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March, 1961

# INDUSTRIAL QUALITY CONTROL



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JOURNAL OF THE AMERICAN SOCIETY FOR QUALITY CONTROL

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# QUALITY CONTROL SHOULD BE COST REDUCTION PROGRAMS

**HARMON S. BAYER,** *Quality Control Consultant, Bayer, Kobert and Associates, Detroit, Mich.*

FEW developments in the science of management require more sound definitions than the concept of the goal of a quality control program. Clearly, quality control programs cannot be considered effective unless they produce substantial cost savings for the organization. All too frequently this basic fact is not understood by those who administer these programs. Unfortunately, a large number of quality control managers still measure the effectiveness of their programs by the number of rejections of product, the number of reports and studies, and the use of other questionable criteria. It is not surprising, therefore, that many of these systems are considered by management to be wasteful. And as a result, the mortality rate of their managers is quite high.

It would perhaps be helpful, therefore, to consider step-by-step methods that management can employ to assure that a quality control program is, in fact, doing its job—producing savings by reducing losses due to poor quality.

### *The "Cost" of Poor Quality Control*

In organizing a cost reduction program for the quality control department the first requirement must be to assess losses that the firm suffers due to quality factors.

Here are some standard ones:

- Scrap or waste produced in the production of the product
- Repair, rework or reoperation
- Downgraded products (seconds)
- Inspection labor costs
- Customer service and rebates (payments to customers to settle quality claims, warranty costs, and policy costs)
- Customer complaints (sometimes hard to dollar value, but loss of quality reputation translates itself into loss of sales)
- Overtime hours caused by reruns or repairs of rejected material
- Downtime caused by interrupted schedules required to remake rejected parts

Often, obtaining these cost estimates is a difficult task since many organizations do not keep adequate records to enable proper assessment of their losses. In these cases, it may be necessary to make preliminary approximations of these losses. We know, of course, that a reasonable approximation can be obtained by the practical method of merely observing various departments for a period of time and recording the losses incurred during the observation period.

Surprisingly, many companies that have realistically appraised these and other quality costs have found that they can run as high as ten to 50 percent of the entire manufacturing cost.

Thus, it becomes quite evident that these demonstrable losses can only be mitigated by a quality control program which, in fact, considers cost reduction as its primary target.

### *Selecting Quality Control Personnel*

A program which will produce substantial cost reductions logically requires mature, professional, competent personnel. Unfortunately, many companies attempt to institute quality control programs with unqualified personnel.

A quality control program should be administered by a manager who fully appreciates the need for: (a) competent inspection management, (b) a quality control engineering staff with adequate experience in statistical engineering and statistical quality control.

This manager's staff, whether it is company personnel assigned to a new program or persons drawn from outside, should be motivated to develop skills in statistical quality control. Standards now being developed by the Professionalism Committee of the American Society for Quality Control may be used as a yardstick for performance that can be expected of these persons.

### *Organizing the Quality Control–Cost Reduction Job*

To assure an effective program, it is necessary that the director of quality control adopt the attitude, "Anything that adversely affects quality is my business." Surely, this is not meant to imply that the quality control manager should unrealistically assume everyone's responsibility. But if any action by any department causes quality problems, it is up to the quality control department to aggressively seek out the facts and encourage those responsible to remove causes of poor quality.

With this in mind, the step-by-step approach

**TABLE I—Scrap Losses by Clock Number**

| | | | |
|---|---|---|---|
| 0003— 1.48 | 0038— 1.71 | 0068—1.86 | 0118— 5.84 |
| 0004— 1.00 | 0039— 2.02 | 0072—1.28 | 0130—17.15 |
| 0005— 0.09 | 0047— 1.10 | 0077—0.52 | 0146—20.58 |
| 0006— 4.46 | 0054—38.66 | 0083—0.90 | 1176— 0.06 |
| 0011—27.68 | 0062— 0.10 | 0085—4.82 | 1465— 0.15 |
| 0031— 0.99 | 0066— 6.13 | 0117—1.07 | |

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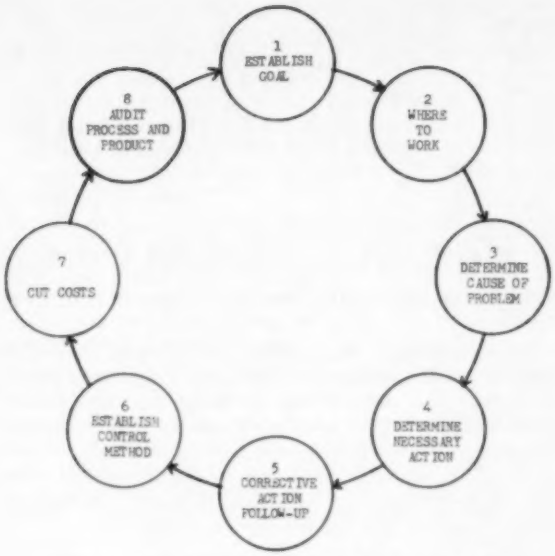


**Figure 1—Organizing the Quality Control-Cost Reduction Job**

toward quality control-cost reduction programs is outlined in Fig. 1.

### *Establish Goal*

A program must have direction. The losses from poor quality listed above should be assessed and a goal and schedule established for reducing this total. Timidity at this point is not commensurate with the experiences in many companies that have had successful programs. Often a reduction goal of 50 percent has proved to be conservative.

Many companies have shown 60 to 75 percent reductions over a five-year period. Subsidiary goals for achieving organization of systems, development of engineering staffs, and other needed planning should also be set at this time. But the fundamental target should be cost reductions.

### *Where to Work*

Usually most people expend their effort in unproductive activity, resulting in a minimum of tangible results. It is because they fail to understand that they have picked the wrong priority for their effort. A concept called Pareto's Principle of Maldistribution can be used to organize information to logically decide what areas of the problem are most susceptible to improvement. As a typical illustration of the principle, note Table I.

Here are listed 23 production operators and the scrap each individual produced during one day. This is the usual way in which data is reported by an accounting system—in this case, in order, according to clock number. To determine the overall pattern of these individual losses, these data are regrouped and placed in rank order from the smallest to the largest loss, retaining the identity of the source of the losses (see Table II). The third column in Table II is now cumulated from the bottom of the column (for example, 38.66 + 27.68 = 66.34; 66.34 + 20.58 = 86.92; etc.). The fourth column converts these data to percent cumulated.

Now we are ready to understand the real significance of our data. The column of figures in Table I is factual, but does not highlight, as does Table II and Fig. 2, the knowledge that five out of 23 operators in the department were responsible for 79 percent of all the scrap. In this instance, the figures are presented for daily scrap only for ease in presentation. Actually it was found that monthly figures consistently showed individual operators in the approximate order that the daily figures showed.

If scrap and other losses are analyzed by these methods, one will determine that the following principle holds almost universally. A small number of areas where losses might occur will usually account for the major portion of those losses. For example:

3 departments out of 10 will cause approximately 80-90% of all losses

3 machines out of 10 will cause approximately 80-90% of all losses

3 people out of 10 will cause approximately 80-90% of all losses

3 defect types out of 10 will cause approximately 80-90% of all losses

3 product identifications out of 10 will cause approximately 80-90% of all losses

Any 3 subdivisions out of 10 will cause approximately 80-90% of all losses

Taking into consideration this principle, one realizes that if a control program tries to blanket all areas, all departments, all machines, all people, it results in largely wasted effort. A much more efficient way to attack any problem is to develop a reporting system which identifies losses and reveals their responsibility in terms of departments, machines, operators, part identification, defect types, and any other logical subdivision. Identifying the sources of the losses and then concentrating on those few responsible areas will consequently reduce the effort *drastically*.

Admittedly, establishing the source information is extremely difficult. An accounting data processing system with a source document which indicates the cost center, identified to such factors as the department, person causing problem, machine, product identification and defect type is of inestimable value. Good cost reduction systems start here and modern data processing systems can quickly subgroup information into any desired breakdown. But companies without modern data processing equipment should not think that they cannot develop similar systems. The author has proved that clerical time spent in

**TABLE II—Calculating the Pareto Distribution**

| Clock Number | Scrap Losses Revised According to Rank Order | Rank Order Cumulated | Percent Rank Order Cumulated |
|---|---|---|---|
| 1176 | 0.06 | 139.65 | 100.00 |
| C005 | 0.09 | 139.59 | 99.96 |
| 0082 | 0.10 | 139.50 | 99.89 |
| 1465 | 0.15 | 139.40 | 99.82 |
| 0077 | 0.52 | 139.25 | 99.71 |
| 0083 | 0.90 | 138.73 | 99.34 |
| 0031 | 0.99 | 137.83 | 98.70 |
| C064 | 1.00 | 136.84 | 97.99 |
| 0117 | 1.07 | 135.84 | 97.27 |
| 0047 | 1.10 | 134.77 | 96.51 |
| 0072 | 1.28 | 133.67 | 95.72 |
| 0003 | 1.48 | 132.39 | 94.80 |
| 0038 | 1.71 | 130.91 | 93.74 |
| 0068 | 1.86 | 129.20 | 92.51 |
| 0039 | 2.02 | 127.34 | 91.18 |
| 0006 | 4.46 | 125.32 | 89.73 |
| 0085 | 4.82 | 120.86 | 86.54 |
| 0118 | 5.84 | 116.04 | 83.09 |
| 0066 | 6.13 | 110.20 | 78.91 |
| 0130 | 17.15 | 104.07 | 74.54 |
| 0146 | 20.58 | 86.92 | 62.24 |
| 0011 | 27.68 | 66.34 | 47.50 |
| 0054 | 38.66 | 38.66 | 27.68 |

analysis of such data is well worth the time and produces actual savings.

The manager responsible for the quality control department program should make certain that this kind of analysis is done on quality losses to assure that a minimum of effort is wasted on unnecessary areas, and effective stress is applied to the high-loss areas.

#### *Determine Cause of Problem*

The director of a quality control program should be aware that a true quality control program is characterized by defect prevention.

The first step in defect prevention in any program is to establish a workable quality engineering effort. The working tools of this staff should be machine and process capability analysis, regression and correlation, design of experimentation, and other advanced statistical engineering methods.

Above all, the staff should be well grounded in economic analysis methods so that their recommendations can be implemented by the dollar impact on the organization, and logical decisions can be made by management on their recommendations.

Through studies and reports generated by this group, the cause of the problem should be isolated and recommendations made for corrective action. Many organizations have a staff which has traditionally carried out this responsibility. In instituting a new quality control program it is well to remember this. Quality analysis and statistical engineering services do not necessarily have to be within the quality control department. It is frequently more sensible, in the light of accepted practice, to reorient the existing analysis departments to quality engineering and statistical engineering techniques of analysis.

The crux of the problem is that it is not generic whether the quality control department actually does the job, but that it is done by someone. In the event that it is done by another department, the quality control responsibility is to assure that it does get done by that department which has this responsibility.

#### *Determine Necessary Action*

Too often programs fail, because after studies have been made, no concrete action is taken. The necessary action may entail a large expenditure and may cause upheaval of processes and equipment. The point to be stressed here is that assignments for action must be made. Assignment schedules must be projected to completion. If the action necessary is not planned and executed properly, the results can only be dissipated effort. The quality control director must accept a personal obligation to see that action and schedules are properly assigned by those responsible.

#### *Corrective Action Follow-up*

Of all the techniques discussed in this article, corrective action follow-up is by far the most important. It is a luxury to take for granted the notion that everyone will do his job. The successful administrator learns that constant follow-up is necessary to assure completed action.

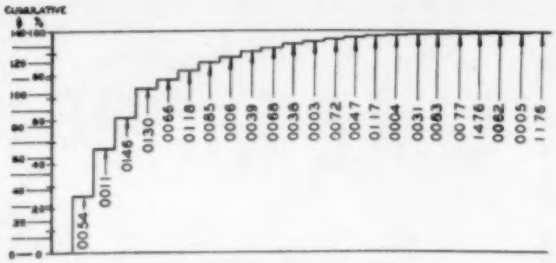


Figure 2—Distribution of Scrap Losses

As an example, let us take the following case and merely list the follow-up actions that were necessary to assure the removal of the largest scrap loss in one company. This was in a machining operation department. The quality control engineer in whose area the scrap was produced found it necessary to take these follow-up measures to assure successful completion of his project—drastic reduction of the scrap:

(a) The original machine capability study determined that a size dimension was responsible for the scrap. A follow-up study of the scrap report after the size dimension was brought under control revealed only a slight lowering of scrap level. A follow-up study revealed that taper was the real cause, not the size dimension involved in the first study.

(b) A new tooling and fixturing method was established to reduce the scrap. Follow-up by the quality control engineer revealed that the tooling engineer, contrary to his assignment, failed to order new tools and fixtures for the entire area. His reason—his budget had been exceeded. The potential savings was better than 20 times the cost of tools and fixtures. A meeting with the tool engineer supervisor was necessary to get authority to purchase one set of experimental tools and fixtures.

(c) The purchasing agent, in turn, delayed the purchase of the tooling because of absenteeism of his stenographer. The quality control engineer convinced the purchasing agent this delay was deleterious to the entire program and it was then swiftly removed.

(d) The experimental study carried out by the production engineering department would have determined that the experimental method provided no improvement were it not for the fact that the quality control engineer observed the study and pointed out faulty control of the experiment. A re-study proved that the new tooling method was sound.

(e) Due to the expense of purchasing sufficient tools and fixtures for the entire area, the project now required a special appropriation request to top management. A three-week delay was prevented because the quality engineer was able to convince the secretary of the top management committee to convene a special meeting rather than wait for the usual monthly meeting.

(f) Constant follow-up with the purchasing agent by the quality control engineer prevented a three-month delay in the delivery of the special tools and fixtures.

(g) When the new tools were first used, a small improvement in scrap loss was noted. Follow-up by

the quality control engineer led to a field engineer's visit by the tool manufacturer. Working with the quality control engineer and the production engineer, the field engineer from the tool manufacturer designed a simple but special adapter for the tools for the majority of machines in the department which were a different make from the one used in the original test. Thus it was shown that the tools were actually adequate.

(h) However, no substantial improvement was noted in the scrap loss reduction. The quality control engineer found that the operators were unfamiliar with the new tools and special training was needed. After the training of the operators, the scrap figure finally took a drastic drop.

(i) However, this improved scrap figure did not remain low. A further study by the quality control engineer noted that some operators were going back to the old type tool. It was discovered that the new tool gave the operators a slightly lower production rate, adversely affecting incentive payments. A restudy of the operations by the industrial engineering department determined a basic methods change involving the new tools which increased the production rate to compare favorably with the previous production rate, and therefore did not adversely affect employee's incentive payments.

(j) Constant follow-up has been necessary to assure that old type tooling will not be used by those operators who still prefer to use the old type tooling.

One must realize that the above case is typical for many operations. The reason for high losses is certainly varied. Reducing these losses is not always simple. What must be understood is that failure to take any one of the follow-up steps described above could have neutralized previous efforts if the quality control engineer did not have the tenacity to see his job through.

In many instances, engineers with a variety of technical backgrounds place undue emphasis on solving management problems by merely using formulas and studies. They frequently dismiss the human and organizational problems as unimportant or easily accomplished. The effective manager on today's industrial scene is aware that it is only through such follow-up as has been described above, by determined individuals, that results are obtained.

#### *Establish Control Method*

Determining the basic technical problem is one thing. Getting corrective action is another. Both of them depend upon the establishing of a control method that can signal trouble. Some types of control methods necessary are as follows:

(a) Quality loss reporting and analysis systems daily
(b) In-process control chart systems
(c) Operator and inspector checking systems to assure good product
(d) In-process and final acceptance inspection systems

Of course, each of these methods will establish the need for current studies, action and follow-up.

#### *Cutting the Cost of the Control System*

Many control systems start with effort placed in logical areas. But as the control system spreads, the effort engulfs the available control manpower. Managers fail to understand that, once solved, the causes of a particular problem may have disappeared. However, we find continually that routine habits become ingrained and people continue to place unnecessary effort in these routines. They fail to realize that during the solving of the problem, people have been trained, new tools and equipment have been purchased, and new production skills have developed. It may now not be necessary to concentrate as much effort on the problem itself. Effective system managers must learn to reduce routine checking and effort by stretching out frequency of checks or dropping them entirely to release manpower for the next problem in order of importance. Of course, if the reduction of effort is too drastic for the problem and the problem recurs, the system must be flexible enough to allow re-establishing the necessary effort to control the situation.

#### *Audit Process and Product*

To assure that the problem continues to be in control, an effective audit system should be established. Customer complaints must be checked regularly. In-process material and finished product must be checked occasionally for the specific defect which has been brought under control. As experience demonstrates the ability of the organization to keep the characteristic in control, the frequency of audit may be reduced drastically. Often the control audit may not be on the product but on the process—for example: A strength problem in a chemical process is now adequately controlled by merely checking a dryer temperature which has proved to be an effective barometer of the strength. The dryer shows excellent control when the system is operating correctly, but drifts when an unbalance develops in the system. A daily check of the dryer has proved sufficient to prevent undesirable characteristics in the process, which, when in control, produces product with adequate strength.

Of course, if the audit indicates that a problem is recurring, it may be necessary to retrace some of the various steps in the "loop" as shown on Fig. 1. However, good experience files should prevent retracing studies previously completed.

By following this "loop" we now have an effective way of removing problems in logical sequence.

#### *Who Is Responsible for Quality*

It is the author's opinion that the best way to establish an effective quality control program is to start with the concept that the operator is fully responsible for the quality of his product, and the ultimate goal is to give him every technique to carry out his responsibility. The same concept sees inspection as merely a "crutch" which the operator will continuously lean upon. Therefore, the author believes the full responsibility for quality must be given to the operator, and his foreman, and systems must be developed which throw the entire responsibility to the operator and gradually remove the inspection "crutch."

Here is how the system may be installed:

(1) The quality capabilities of all operations and processes causing quality difficulties are studied to assure that *management* is not responsible for causing poor quality. It is not logical to expect an operator to

produce quality which is over and above that which the process or machine *can* produce. This is a management responsibility. The causes of poor quality must then be identified and removed to assure that the operator is now fully capable of maintaining the quality of his operation. Only when this is done can management fairly require that the operator be fully responsible for his quality.

(2) The operator is given all the information he needs about what is expected from him in terms of quality, specifications, etc. This is done by developing a production quality instruction sheet for each operation. This is usually a switch from the past—all too frequently we find operators working in the dark as to the quality requirements necessary. Often the inspector is only a little better informed than the operator. Sometimes both are confused.

(3) The operator is given all the gages and technical equipment he needs to check enough product to assure himself that the quality is adequate. We frequently find inspection supervisors objecting to this; the excuse is that the operator is not to be trusted with delicate gages. This is usually "empire building" on the part of inspection personnel. Consider the fact that we trust an operator with production equipment whose cost far exceeds that of any gage. It is seldom that one finds an operator who cannot be trained to use any gage. Sometimes it is impossible to give an operator a gage because of the length of time needed to check a characteristic.

(4) The operator is given sufficient time in his pay standard to check enough pieces to assure himself that he is making adequate quality. Upon investigation, we may find that an excess of checking time is already in his standard and it costs no more to gain adequate control. However, it may be necessary to change the standard to include some inspection time. Then we can fairly require quality of the operator, since we now know he has the opportunity to observe for himself the quality of his product. In the event the operator must have a special checking method, such as a control chart or a sampling plan, the operator is paid to perform the charting or sampling for himself to help make him aware of the problem of adequate quality.

(5) An adequate in-process identification system is developed so that any product can be attributed to the operator performing each step of the production. When each operator is finished with the product, he signs an "operator certification ticket" (usually the lot identification card) and this signifies that he certifies to the quality of the product he produced.

(6) Inspectors are assigned to check product at each stage of the operation—only checking *certified lots* to determine whether each individual operator can, in fact, certify his lots. Reports are made to production supervisors on all operators and their attention is called to chronic "unacceptable certifiable operators."

(7) "Certifiable operator" is made a condition of employment and corrective action is taken with any chronic cases of operators who are not performing adequately. Of course, authority for this action rests with the production supervisor.

(8) When it becomes apparent that rejects and scrap and hence quality are improved, the inspectors are gradually pulled from the process and from the final line. Sufficient audit inspections are retained to assure that the quality picture does not later develop an undesirable turn. Usually final inspection can be curtailed or even removed entirely except on those performance characteristics which are of a critical or legal nature and must be checked.

### *Schedule Your Program*

One principle of good management which is too often ignored by the quality control department is to establish a specific schedule for the program. Goals must be set for activities and for the actual dollar pay-off of the program. Sub-goals should be assigned to supervisors in the program so that the entire program coordinates toward meeting projected over-all goals.

One word of caution. Don't be unrealistic in your plans. A full, effective program usually takes about five years. However, the actual breakpoint of savings overcoming expenditures should materialize between one and two years after the program is launched. From that point on, savings should increase.

One other note. Schedules are made to be met—not adjusted to agree with what has actually been accomplished. The difference between the effective manager and the ineffective one is the ability of the former to plan, schedule and *produce.*

### *Typical Examples of Results*

(1) Within nine months a large brass manufacturer saved in excess of $100,000 over and above the entire investment in his quality control program. His customer complaints were drastically reduced.

(2) A rubber manufacturer paid off the investment in his program and produced further savings by reducing his scrap losses to less than 20 percent of the former level within six months. Customer rebates were also drastically reduced.

(3) Through the quality control program a high-precision machining plant revealed some basic problems of machines and methods. These were corrected and quality improved. Notwithstanding the cost of correcting the processes, the program was paying for itself within four months after it was started. Customer reaction improved steadily while overall savings mounted.

(4) A ceramic manufacturer has substantially reduced his scrap level. His quality complaints have been reduced to a minimum. The quality control engineering department has become most effective in working with the organization to achieve: (a) the constant improvement of process methods, (b) substantial production cost curtailment.

### *Conclusion*

Briefly, then, how does one establish a quality control-cost reduction program?

First, the concept is established within the organization that the operator and his foreman are fully responsible for the quality of his operation.

Second, systems are developed to assure that those responsible for poor quality (management or operator) are identified.

Third, the economic order of each loss is evaluated and priorities for action are chosen (Fig. 2).

Fourth, each priority problem is attacked with the methods illustrated in Fig. 1. One by one the "loop" shown is closed to each problem and the result is a sharp *reduction* in *losses* in *scrap, repair, inspection labor, customer complaints* and *rebates* and *other quality losses.*

# MECHANIZATION

# QUALITY CONTROL

# AND AUTOMATION

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### *Introduction*

In the rapidly growing field of electronics, the problems associated with increasing quality and new demands for reliability represent an ever increasing challenge. There is a direct relationship between the emphasis placed on the reliability and quality of a product, and the importance of the functions which they perform.

Increasing quantities of life tests and environmental tests to measure and prove reliability as well as grade quality, place an increasing demand for automation, mechanization, and revised Quality Control procedures.

This article presents the need for research into new concepts of automatic test facilities which will provide the types of equipment that are required to constantly evaluate, in quantity, the reliability of electronic systems and components.

The need of a facility designed to provide highly reliable and precise test data for transistors and other miniaturized electronic components by automatically testing and recording parameter values is discussed.

### *Theoretical Relationship of the Uncontrolled Variables to the Homogeneity of Devices*

The American consumer has raised his quality standards to a new high and the military customer has been forced to demand very stringent reliability requirements. Industry in general is as concerned with quality assurance as the American public or the Government. Responsible manufacturers are keenly aware of the need for reliable industrial and military equipment, and in some instances have set up extensive programs to assure its attainment.

Mechanization and automation have in the past years become keys to the success of many types of industry. The rapid pace set by the progress of technology in the electronics industry has voided standard quality control methods. Many of the quality control practices which are routine for tried and proven industrial problems must be cast aside for the more theoretical and untried methods required to solve many of the new problems confronting the electronics industry.

The ideal situation in the component manufacturers plant would be good incoming materials, excellent process fabrication techniques with properly balanced quality control, adequate technical and semiskilled personnel, high volume production with automation, low cost high quality end-product and satisfied customers. However, many of these attributes are complicated with detering factors such as:

1. Meager concepts of quality control due to lack of competent personnel
2. New devices introduced without proper test equipment to measure and evaluate them
3. Changes in techniques of production and modified production processes creating a need for means of rapidly evaluating the new methods prior to mass production
4. Large volume production created by product

ASQC LCS Code 700:60:436

Figure 2—The Loading End of the Centralized Automatic Tester and the Main Control Console

demand without sufficient time to analyze information obtained on production problems

5. Keeping abreast of the industry requirements causing new devices to be developed and produced without sufficient technical information on end application
6. Unproven processes during early "state of the art" developments creating the need for a method of quickly choosing, adapting and controlling the right process for meeting the customer's needs

### *Methods of Controlling the Variables*

To alleviate these factors, several interim steps may be pursued. Complete automation is usually an

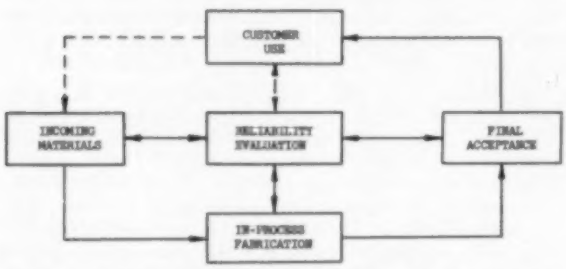


Figure 1—Material Flow and Communication Links in a Typical Component Manufacturing Process

ideal situation although it is not always desirable. Management must consider all aspects of the steps which will lead them to the solution of their specific problems. Fig. 1 shows a closed loop system of material flow and communication links in a typical component manufacturing process. Beginning at the incoming materials stage there are several types of measurements which are performed on a wide variety of raw materials. These include chemical, electrical, mechanical and thermal measurements. In a majority of the cases this link does not readily lend itself to complete automation or mechanization.

The in-process fabrication link is easier to adapt to automation and mechanization because of the following factors:

1. Whereas in the incoming materials stage the wide variety of materials are checked and analyzed for use in many different processes, the materials used on specific production lines are more homogeneous, thus making a more uniform product
2. The repetitive nature of specific points within the manufacturing process which may be mechanized and measured

In the semiconductor industry the final acceptance link is most susceptible to complete automation and mechanization for many reasons. Among those are:

1. Many tests and measurements must be performed on large quantities of like devices
2. Electrical classification and mechanical sorting must be accomplished on every device made

In every instance where large volumes of devices are subjected to 100 percent testing, the use of automatic equipment is a prime requirement to ensure acceptable results.

During the early stages of a new industry such as semiconductor manufacturing, large quantity measurements of the various parameters of the products were done by hand. Special hand test sets had to be set up for different types of device evaluations, and distributions of the data were made by desk clerks. Since most of the readings taken were visual and the data recorded was by hand, many chances for error were introduced.

As production requirements increased the brute-force hand testing and measuring methods had to be replaced. Automatic testing methods offered increased speed, greater accuracy, improved safety, reduced costs, greater flexibility, and as an option, a permanent data record.

One of the innovations in the final acceptance link by Texas Instruments Semiconductor Components Division was the Centralized Automatic Tester (CAT). This facility is a semiautomatic transistor testing machine suitable for production use. Fig. 2 shows the loading end of the machine and the main control console. The control console supplies all of the power and timing signals to operate and cycle the test and sorting stations. The test rate can be adjusted so that up to 2000 units per hour can be processed.

A temporary memory in the form a punched card is carried along with each transistor as it is moved down the test line. Sorting is done from the information punched on the card with a mask and a

Figure 3—Some of the CAT Facility Test and Sorting Stations

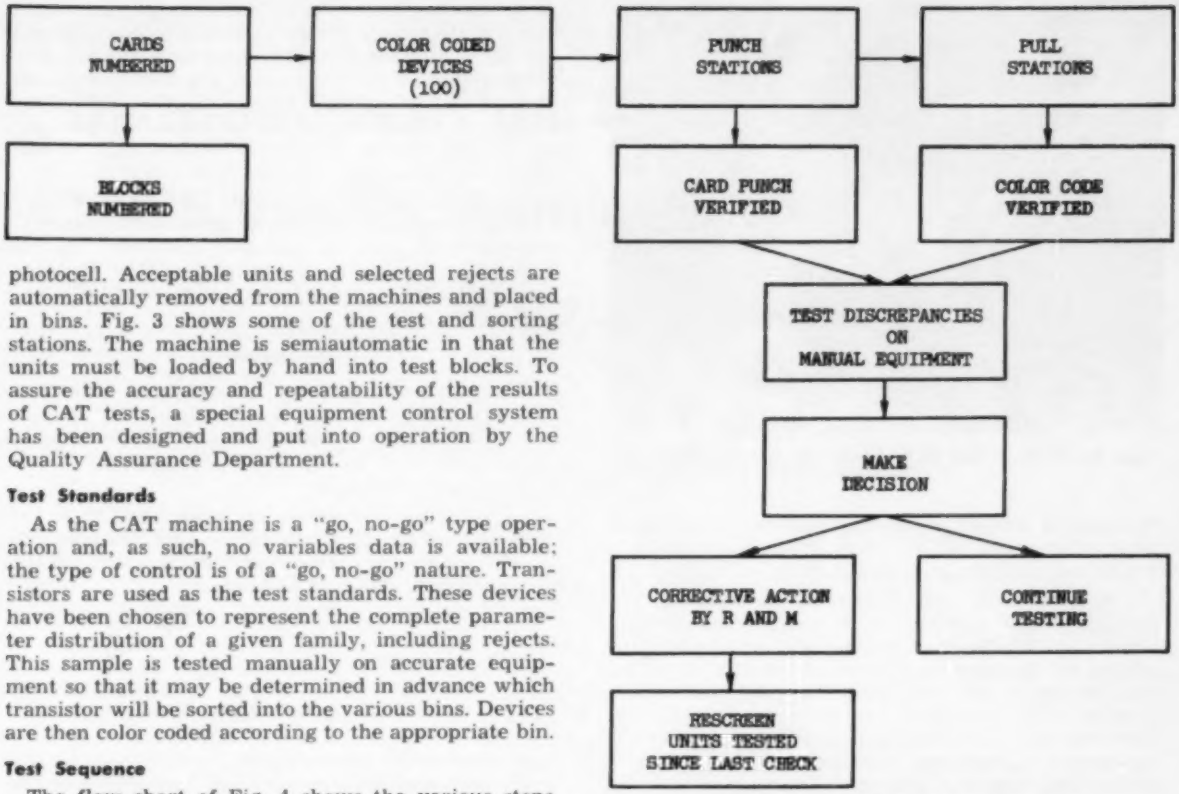


Figure 4—Steps Taken During the CAT Control Procedure

photocell. Acceptable units and selected rejects are automatically removed from the machines and placed in bins. Fig. 3 shows some of the test and sorting stations. The machine is semiautomatic in that the units must be loaded by hand into test blocks. To assure the accuracy and repeatability of the results of CAT tests, a special equipment control system has been designed and put into operation by the Quality Assurance Department.

#### Test Standards

As the CAT machine is a "go, no-go" type operation and, as such, no variables data is available; the type of control is of a "go, no-go" nature. Transistors are used as the test standards. These devices have been chosen to represent the complete parameter distribution of a given family, including rejects. This sample is tested manually on accurate equipment so that it may be determined in advance which transistor will be sorted into the various bins. Devices are then color coded according to the appropriate bin.

#### Test Sequence

The flow chart of Fig. 4 shows the various steps taken during the control procedure. The test blocks are permanently marked for positive identification and the number of both the transistor and the test block are written on the punch card which serves as the memory unit. As the block moves along the line, various punches are made in the card at the test stations; the number of holes depends on whether or not the transistor meets the particular limit at each of the test stations. When a given unit has been tested, it is pulled into one of the sorting bins at the end of the line. The exact bin in which the test unit appears depends upon the arrangement of holes punched in the card. Since each transistor has been checked in advance for each parameter the CAT is sorting, it should be known that the card will assume a definite hole pattern and the transistor will end up in a certain bin.

#### Analysis and Corrective Action

At the end of the test line the punch cards are collected and held for further reference. When all of the units have been sorted into bins, the technician makes a visual inspection of all the bins, looking for a color-coded unit which might be in the wrong bin. When one is located, the card for that device is checked to locate the error. When this is determined, the unit is tested on a hand test set to ascertain whether or not the CAT machine was in error. When the CAT machine is found to be in error, necessary corrective action is taken by qualified personnel. A further check on the accuracy is then made by comparing the punch cards to a set of cards that have been previously punched according to each unit's classification. If any difference in the punches is noted, it is then determined which punch station is in error. After the necessary corrective action is taken the units which were in error are retested as a final check. Occasionally, punches are made on a card and, upon checking the stations in error, no apparent reason for the error can be determined. Then the block number is taken from the card and the block is checked to determine if it is defective. When a block is found to be defective it is removed from the test line until it has been repaired.

#### Other Tests

There are other control systems that could be used that would be quite satisfactory, such as sampling each bin on a regular basis to spot errors. However, this technique requires that each transistor of the sample be tested for every test station that appears on the CAT. By the time results of a test of this nature are completed the CAT may have tested several thousand transistors in the interim.

#### Advantages

The main advantages of the system presently employed are:

1. Since the same transistors are used each day, an analysis of the repeatability of the CAT is readily available
2. Fast feedback of information is possible
3. Minimum personnel is required to conduct the tests
4. Complete analysis of the punch and pull stations permits maintenance to locate trouble spots quickly

Keeping in stride with engineering technology in the automation field the Facility for Automatic Sort- and Testing (FAST) machine was developed. One

**Figure 5—An Overall View of the Facility for Automatic Sorting and Testing**

of the basic advantages of this machine is that feedback information in the form of variables data is available.

Fig. 5 shows an overall view of the machine. The individual test stations in this equipment contain automatic recalibrating circuits and additional provisions to turn the equipment off should a portion malfunction. Each test station is provided with a readout system so that data may be recorded on punched tape or typewritten. Another feature of the equipment is that the transistor is placed in one socket and is passed through all tests before being removed. This method keeps the lead flexing during testing to an absolute minimum.

A third and final example whereby automation is essential is that of life testing for Reliability Evaluation. To provide the services needed for Reliability Evaluation on a large scale operation, complete automation is highly desirable. The facilities to provide such a service must incorporate:

1. Variables data in useable form
2. High reliability of test
3. High resolution
4. High sensitivity
5. Maximum accuracy consistent with the state of the art
6. Methods whereby special tests above and below normal temperatures may be run

The Sequential Mechanism for Automatic Recording and Testing (SMART) is such an automatic test facility which was designed and built at Texas Instruments for use in Reliability Evaluation. Fig. 6 shows the SMART machine. It is a machine capable of performing up to 16 sequential tests on a device while recording the desired data in a three-digit readout on a punched card. Accessory consoles can be connected to extend this range to cover AC, high frequency, and pulse tests.

The sequencing is at the control of the operator in a Sequence Control Unit. Any number of tests between one and 16 may be selected or skipped. If only a few tests are planned, these tests may be performed and the Sequence Control is homed without stepping through the remaining tests. The conditions of any test may be selected on a Program Unit. The variables of programming include level and point of application of test voltages or currents; point of grounding test circuit; duration of test; level; polarity; terminals where readout is to be measured; and level of reject trips. The readout is fed to a differential input digital voltmeter. The digital voltmeter is used with an external trigger, supplied by a timer circuit. A digital display of the readout is provided on the front panel. A transfer register also converts the input into relay closures. These closures are in turn used to activate punches in an IBM card punch.

Once the data has been accumulated it becomes necessary to perform standard statistical analyses and special engineering evaluations. The statistical analyses may be readily done using computer programs.

### *Conclusions*

The increasing quality demands and higher reliability requirements in the Semiconductor Industry can only by met by automation. Some outstanding benefits derived from automation include:

1. Greater Accuracy
   a. Correlation factors are established to provide methods of prediction so that the standards continually represent the product quality which the customer desires
   b. Selection of the parts at the proper quality level can be made
2. Increased Flexibility
   A rapid and continuous check is made into the effects of materials used on the deterioration of the finished parts
3. Permanent Data Record
   It provides management with sufficient information to make decisions in regard to cost versus market

The manufacturer of Semiconductor Components must provide increased mechanization and automation:

1. To adequately provide feedback within his own plant
2. To provide increased customer services as required
3. To meet the increased high reliability requirements placed on his products

The manufacturer must also refine the basic quality control concepts to keep abreast of the changes which occur due to automation.

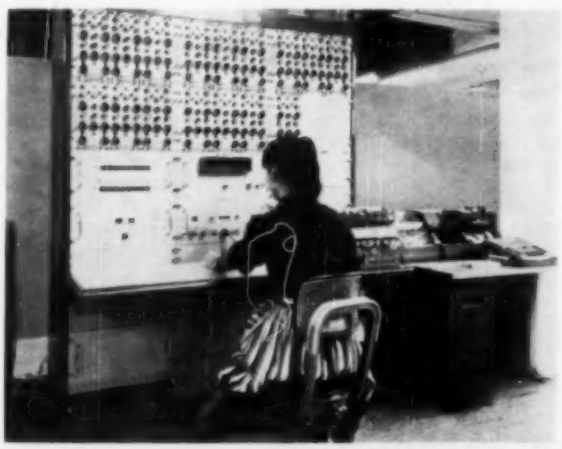

**Figure 6—The Sequential Mechanism for Automatic Recording and Testing**

# Distribution of the Range and Midrange When Sampling from a Negatively Skewed Right Triangle Population

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THE DISTRIBUTIONS of the range and midrange of n observations have been investigated when sampling from a negatively skewed right triangle population. A table giving the mean and standard deviation of the range and midrange for sample sizes two through 25 has been included.

### *Introduction*

Information on the sampling of non-normal populations is, in general, sparsely reported in the literature. In a recent publication[1], Ostle and Wiesen described an acceptance sampling plan based on the distribution of the range when sampling from a right triangle population. At the suggestion of one of the referees of this earlier paper, a more extensive investigation of the underlying distribution has been undertaken. An evaluation of the distributions of the range and midrange when sampling from a negatively skewed right triangle population has been carried out and values of the mean and standard deviation of the range and midrange are given.

### *Application of Results*

As stated in Reference 1, one of the acceptance tests performed on a certain type of cold cathode tube concerns itself with the jitter of the tube. (Jitter is defined as the anode delay time variation measured by the range of n observations, that is, the longest delay time minus the shortest delay time). If one considers each tube as a (production) lot of delay times—a very large lot—then operating a tube n times, and measuring the delay time on each operation, may be considered equivalent to inspecting a sample of n from a particular lot.

ASQC LCS Code 420:00:000

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If we consider the possibility of in-process control of tube production, rather than acceptance sampling as in Reference 1, it seems natural to make use of control chart techniques. Since the distribution of delay times is approximately triangular so that the common multipliers $D_3$ and $D_4$ (based on a normal population) cannot be used, it is necessary to obtain the mean and standard deviation of the sample range before limits for an R-chart can be evaluated. Further, because of the ease of calculation, it was suggested that an M (midrange) chart be used in place of the conventional $\bar{X}$ chart. Consequently, the mean and standard deviation of the sample midrange were also determined. However, tables of constants (equivalent to $A_2$, $D_3$, and $D_4$) were not obtained since this type of in-process control was not adopted for the example cited. If needed, such constants can easily be calculated.

### *Some Fundamental Theory*

If u and v are the smallest and largest values, respectively, in a random sample of size n from a population described by the probability density function $f(x)$, $a \leq x \leq b$, it is well known[2] that

$$h(u,v) = n(n-1)\,[F(v) - F(u)]^{n-2} f(u) f(v) \quad (1)$$

where

$$F(x) = P\{X \leq x\} = \int_a^x f(x)\,dx \quad (2)$$

The distribution of the sample range, R, defined by $R = v - u$, may then be found by evaluating

$$g(R) = n(n-1) \int_a^{b-R} [F(u+R) - F(u)]^{n-2} f(u) f(u+R)\,du \quad (3)$$

or

$$g(R) = n(n-1)\int_{a+k}^{b}[F(v) - F(v-R)]^{n-2} f(v-R)f(v)dv \quad (4)$$

whichever is preferred.

Rider[3] has shown that, if we denote the midrange by M and the half range by z, that is,

$$M = (u+v)/2 \quad (5)$$

and

$$z = (v-u)/2 \quad (6)$$

then

$$\phi(M,z) = 2n(n-1)[F(M+z) - F(M-z)]^{n-2} f(M-z)f(M+z) \quad (7)$$

Since $R = 2z$, it is a simple matter to obtain

$$p(M,R) = n(n-1)\,[F(M+2R) - F(M-2R)]^{n-2} f(M-2R)f(M+2R) \quad (8)$$

that is, the joint distribution of the midrange and range. From this distribution, one may obtain the marginal distributions of the range and midrange.

An alternative method of obtaining the distribution of the midrange is the following: Starting with Equation 1, and letting $y = u/2$ and $M = (u+v)/2$, it may be shown that

$$q(M) = 4n(n-1)\int_{S}[F(2M-2y) - F(2y)]^{n-2} f(2y)f(2M-2y)dy \quad (9)$$

where S represents the proper region of integration [e.g., $S = (0, M/2)$ for a variable having the range $x > 0$].

From the preceding distributions, one may determine the mean, median and standard deviation of the range and midrange.

### *Distributions of the Range and Midrange*

Consider the population illustrated in Figure 1 and described by the density

$$f(x) = 2x/(R')^2, \quad 0 < x < R'$$
$$= 0, \quad \text{elsewhere} \quad (10)$$

for which $\overline{x'} = 2R'/3$ and $\sigma_{x'} = R'/2\sqrt{3}$. Invoking the theory outlined in the preceding section, it is seen that

$$h(u,v) = 4n(n-1)\,uv(v^2-u^2)^{n-2}/(R')^{2n}, \quad 0 \le u \le v \le R' \quad (11)$$

and

$$g(R) = \frac{4n(n-1)R^{n-2}}{(R')^{2n}}\int_{R}^{R'}(v^2 - Rv)(2v-R)^{n-2}dv$$
$$= \frac{2nR^{n-2}}{(R')^{2n}}\left\{R'(R'-R)(2R'-R)^{n-1} - \frac{(2R'-R)^{n+1}}{2(n+1)} + \frac{R^{n+1}}{2(n+1)}\right\}$$
$$= \frac{n(n-1)R^{n-2}}{2(R')^{2n}}\left\{\frac{(2R'-R)^{n+1}}{n+1} - \frac{R^2(2R'-R)^{n-1}}{n-1} + \frac{2R^{n+1}}{n^2-1}\right\} \quad (12)$$

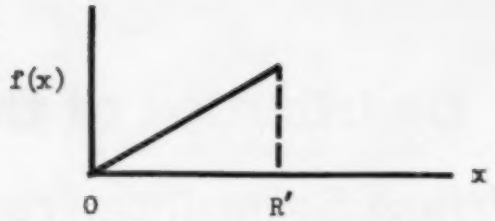


**Figure 1—Probability Density Function Defined by Equation 10**

where $0 \le R \le R'$. Also,

$$p(M,R) = \frac{2^{2(n-1)}n(n-1)}{(R')^{2n}}M^{n-2}(M^2R^{n-2} - 4R^n) \quad (13)$$

and

$$q(M) = \frac{n2^{2n}M^{2n-1}}{(n+1)(R')^{2n}}; \quad 0 < M < \frac{R'}{2}$$
$$= \frac{n2^{2n}M^{n-2}(R'-M)^{n-1}}{(n+1)(R')^{2n}}\left\{M^2 + R'(n-1)M - (R')^2\frac{(n-1)}{2}\right\}; \quad \frac{R'}{2} < M < R' \quad (14)$$

### *Mean, Median and Standard Deviation of the Range*

Using standard notation, it is seen that

$$\overline{R'} = E(R) = \int_0^{R'} Rg(R)dR$$
$$= \frac{n(n-1)}{2(R')^{2n}}\int_0^{R'} R^{n-1}\left\{\frac{(2R'-R)^{n+1}}{n+1} - \frac{R^2(2R'-R)^{n-1}}{n-1} + \frac{2R^{n+1}}{n^2-1}\right\}dR$$
$$= \frac{2R'}{2n+1}\left\{n - 2^{2n}(2n+1)\,B_{1/2}(n+1, n+1)\right\} \quad (15)$$

where

$$B_x(p,q) = \int_0^x y^{p-1}(1-y)^{q-1}dy \quad (16)$$

is the Incomplete Beta Function. Similarly,

$$E(R^2) = \int_0^{R'} R^2 g(R)dR$$
$$= \frac{(R')^2}{2(n+1)^2}\left\{(2n^2+6n+3) - 2^{2n+3}(n+1)^2\,B_{1/2}(n+1, n+2)\right\} \quad (17)$$

It is now a straightforward matter to evaluate $\overline{R'} = E(R)$ and $E(R^2)$ using tables[4] of the ratio

$I_x(p,q) = B_x(p,q)/B(p,q)$ in which $B(p,q) = B_1(p,q)$ and thus determine $(\sigma_R')^2$ and $\sigma_R'$ using the well-known identity

$$(\sigma_R')^2 = E(R^2) - [E(R)]^2 \qquad (18)$$

To determine the median of the range, it is necessary to solve Equation (19) for $\tilde{R}$.

$$P\left\{R \leq \tilde{R}\right\} = \int_0^{\tilde{R}} g(R)dR = 0.50 \qquad (19)$$

Setting $\tilde{R} = R'/a$, we obtain

$$(n+1)a^{2n} - (2a-1)^n(2n\,a+1) - 1 = 0 \qquad (20)$$

This must be solved for $a$ from which $\tilde{R}$ can be determined. Values of the mean and standard deviation of the range are given in Table I for sample sizes $n = 2, \cdots, 25$. Values of the median are not given because of the difficulties involved in solving Equation (20).

***Mean, Median and Standard Deviation of the Midrange***

Following the same procedure as in the preceding section, it is found that

$$\begin{aligned}\overline{M}' &= E(M) \\ &= \frac{nR'}{2(n+1)(2n+1)} + \frac{nR'\,2^{2n}}{(n+1)} \\ &\quad \Big\{ B(n+2,n) - B_{1/2}(n+2,n) \\ &\quad + (n-1)B(n+1,n) - (n-1)B_{1/2}(n+1,n) \\ &\quad - \frac{(n-1)}{2}B(n,n) + \frac{(n-1)}{2}B_{1/2}(n,n) \Big\} \qquad (21)\end{aligned}$$

Also,

$$\begin{aligned}E(M^2) &= \frac{n(R')^2}{4(n+1)(2n+2)} + \frac{n(R')^2\,2^{2n}}{n+1} \\ &\quad \Big\{ B(n+3,n) - B_{1/2}(n+3,n) \\ &\quad + (n-1)B(n+2,n) \\ &\quad - (n-1)B_{1/2}(n+2,n) \\ &\quad - \frac{(n-1)}{2}B(n+1,n) \\ &\quad + \frac{(n-1)}{2}B_{1/2}(n+1,n) \Big\} \qquad (22)\end{aligned}$$

Equations (21) and (22) may be used to evaluate $\overline{M}'$, $(\sigma_M')^2$ and $\sigma_M'$ for the desired values of n. To determine the median of the midrange, Equation (23) must be solved for $a$ where $1 \leq a \leq 2$ and $\tilde{M}$ determined using the relationship $\tilde{M}a = R'$.

$$\begin{aligned}\frac{1}{n2^{2n+1}} &= B_{1/a}(n+1,n) - B_{1/2}(n+1,n) \\ &\quad + (n-1)B_{1/a}(n,n) - (n-1)B_{1/2}(n,n) \\ &\quad - \frac{(n-1)}{2}B_{1/a}(n-1,n) \\ &\quad + \frac{(n-1)}{2}B_{1/2}(n-1,n) \qquad (23)\end{aligned}$$

Values of the mean and standard deviation of the midrange are given in Table II for sample sizes $n = 2, \cdots, 25$. Values of the median are not given because of the difficulties involved in solving Equation (23).

**TABLE I—Mean and Standard Deviation of the Sample Range when Sampling from a Negatively Skewed Right Triangle Population**

| Sample size = n | $\overline{R}'/R'$ | $\sigma_{r'}/R'$ |
|---|---|---|
| 2 | 0.26666 | 0.71181 |
| 3 | 0.39999 | 0.69037 |
| 4 | 0.48253 | 0.66394 |
| 5 | 0.53969 | 0.63935 |
| 6 | 0.58210 | 0.61757 |
| 7 | 0.61506 | 0.59844 |
| 8 | 0.64165 | 0.58149 |
| 9 | 0.66358 | 0.56647 |
| 10 | 0.68213 | 0.55296 |
| 11 | 0.69804 | 0.54076 |
| 12 | 0.71183 | 0.52975 |
| 13 | 0.72395 | 0.51970 |
| 14 | 0.73483 | 0.51028 |
| 15 | 0.74449 | 0.50174 |
| 16 | 0.75322 | 0.49377 |
| 17 | 0.76105 | 0.48651 |
| 18 | 0.76826 | 0.47964 |
| 19 | 0.77492 | 0.47312 |
| 20 | 0.78106 | 0.46699 |
| 21 | 0.78670 | 0.46127 |
| 22 | 0.79190 | 0.45595 |
| 23 | 0.79682 | 0.45078 |
| 24 | 0.80153 | 0.44567 |
| 25 | 0.80584 | 0.44099 |

**TABLE II—Mean and Standard Deviation of the Sample Midrange when Sampling from a Negatively Skewed Right Triangle Population**

| Sample Size = n | $\overline{M}'/R'$ | $\sigma_{M'}/R'$ |
|---|---|---|
| 2 | 0.66667 | 0.16664 |
| 3 | 0.65715 | 0.13472 |
| 4 | 0.64762 | 0.11597 |
| 5 | 0.63925 | 0.10330 |
| 6 | 0.63204 | 0.09407 |
| 7 | 0.62579 | 0.08701 |
| 8 | 0.62036 | 0.08118 |
| 9 | 0.61557 | 0.07655 |
| 10 | 0.61131 | 0.07273 |
| 11 | 0.60752 | 0.06921 |
| 12 | 0.60409 | 0.06641 |
| 13 | 0.60098 | 0.06356 |
| 14 | 0.59813 | 0.06140 |
| 15 | 0.59552 | 0.05933 |
| 16 | 0.59310 | 0.05762 |
| 17 | 0.59088 | 0.05577 |
| 18 | 0.58876 | 0.05459 |
| 19 | 0.58687 | 0.05301 |
| 20 | 0.58506 | 0.05167 |
| 21 | 0.58339 | 0.05000 |
| 22 | 0.58178 | 0.04930 |
| 23 | 0.58029 | 0.04785 |
| 24 | 0.57886 | 0.04690 |
| 25 | 0.57752 | 0.04593 |

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(3) Rider, P. R., "The Midrange of a Sample as an Estimator of the Population Midrange," *Journal of the American Statistical Association*, Vol. 52, No. 280, pp 537-542, December, 1957.

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# Examples of Designed Experiments

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### *Introduction and Summary*

Text book examples of designed experiments usually refer to a single design, where the standard statistical methods, such as analysis of variance, can be satisfactorily applied. All too often, however, this does not hold true in practical situations. The main purpose of this article is to describe two case histories taken from industrial experience, where statistical thinking was of fundamental importance but where text book theories did not apply.

The first of these was an experiment on swaged joints with nine factors, where a series of seven successive experiments produced a satisfactory answer, without requiring any of the more sophisticated methods of analysis; the second, a problem on electric fuses, presents a situation which appears very similar to the first one, but where quite a different approach was needed.

### *Example I — Swaged Joints*

This example refers to the production of swaged joints, an operation used on an extensive scale for fixing various components to the chassis of radio sets, television sets, etc. The principle is illustrated in Fig. 1. A metal rod R is provided on top with a collar C which is passed through the hole H in a plate P. Then a rotating tool T is pressed into the collar and forces the protruding rim sideways and against the plate thereby establishing a rigid connection between R and P.

When conditions are not suitable the rim of the finished joint has a rough appearance and shows cracks, which impair the mechanical strength of the connection. In the factory, considerable trouble of this kind was experienced and experiments were required to improve the situation.

We begin by enumerating the factors which may have an influence and the observations that can be made.

ASQC LCS Codes 523:60;70:434;436

Text of a lecture delivered in Paris, July 4, 1959.

### Conceivable Factors

1) M Materials: Steel I, Steel II, Aluminum, Brass, Lots.
2) D Diameter of the collar,
3) W Wall thickness of the collar,
4) H Height of the collar above the plate,
5) P Amount of play between collar and plate,
6) S Shape of the tool; two tools, A and B, were in use of which A was considered the best,
7) N Number of revolutions per minute of the tool or speed of rotation,
8) T Time used in establishing the joint,
9) L Lubricant; two lubricants were in use but the influence of the lubricant was thought unimportant.

**Table I—Results of the First Experiment**

A. Tensile strength T

| Time (sec) | 0.4 | 0.7 | 1.0 | |
|---|---|---|---|---|
| Height (mm) | Mean strength in kg | | | Mean |
| 0.7 | 201 | 195 | 191 | 196 |
| 0.9 | 211 | 211 | 203 | 208 |
| 1.1 | 185 | 215 | 207 | 202 |
| 1.3 | 166 | 168 | 134 | 156 |
| Mean | 191 | 197 | 184 | |

B. Standard deviations

| 0.4 | 0.7 | 1.0 |
|---|---|---|
| Standard deviation in kg | | |
| 16 | 20 | 30 |
| 12 | 14 | 14 |
| 29 | 6 | 26 |
| 53 | 30 | 40 |

C. Mean scores

| Time (sec) | 0.4 | 0.7 | 1.0 |
|---|---|---|---|
| Height (mm) | Mean score | | |
| 0.7 | 4.0 | 4.2 | 5.8 |
| 0.9 | 5.2 | 6.0 | 5.2 |
| 1.1 | 3.6 | 6.0 | 4.2 |
| 1.3 | 1.6 | 1.6 | 0.6 |

### Observations

1) Visual judgment of the appearance of the joint; scores were used going from
   6 = very smooth, to
   0 = very rough and heavily cracked.
2) The tensile strength in kilograms measured by tearing plate and rod apart.

In principle it would be possible to design experiments in which all nine factors are varied simultaneously, but in a situation like the present one such experiments would be far too complicated. The observations are of a comparatively simple nature and can be carried out in a short time. Under these circumstances a series of simple experiments is to be preferred. This also has the advantage that in design-

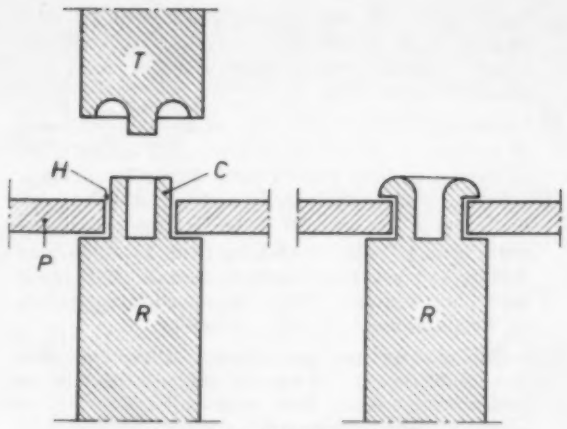


**Figure 1—Illustrating the Production of a Swaged Joint**

ing the next stage we can make use of the experience previously gained.

Hence a first problem is to select the factors to be varied in the initial experiment. The following arguments decided our choice:

a) Steel I is known to be the most difficult material. It is likely that conditions giving good joints for this material will also be satisfactory for the other materials. Hence we begin with the Steel I.

b) The diameter cannot easily be changed in one experiment, because that would require elaborate resetting of the automatic lathes on which the collar is machined. The smaller the diameter, the larger will be the plastic deformation while making the joint. Hence the smaller diameters will be more difficult than the larger ones. We begin with a fairly small diameter, in the hope that the results can in a simple way be extrapolated to larger diameter. This turned out to be correct.

c) It would be uneconomic in production to prescribe too narrow tolerances on the amount of play. We therefore decided to start with tolerance specifications that can easily be maintained in practice. Narrower tolerances will be tried out only when the experiments indicate that this is essential.

d) The shape of the tool can be varied in many ways. Again it seemed better not to vary this factor unless this should appear strictly necessary. We may start by using the best one of the two existing tools, tool A.

e) As lubricants were considered not important we used a single lubricant, machine oil, in our experiments.

These arguments leave us with four factors—wall thickness, height, speed of rotation, and time—to be varied at the outset. As an experiment with all four would still have been rather complicated and as we first wanted to gain some experience, we started with two factors, height and time; this choice was arbitrary. Since it was evident that the quality of a joint would go through an optimum with height H, too little or too much material being both undesirable, four levels were chosen for this factor. For the time T three levels were considered sufficient. For each of the 12 combinations of height and time five joints were produced.

**Table II—Swaged Joints**

**(Summary of the Series of Seven Successive Experiments)**

| Experiment | I | II | III | IV | V | VI | VII |
|---|---|---|---|---|---|---|---|
| Factor | Levels of the factors | | | | | | |
| Material, lots | Steel I 1 | Steel I 1 | All 4 5 | All 4 1 | Steel I 1 | All 4 1 | All 4 1 |
| Diameter (mm) | 2.8 | 2.8 | 2.8 | 2.8 | 6.8 14.8 | 6.8 14.8 | 1.0 |
| Wall thickness (mm) | 0.6 | 0.5 0.6 0.7 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 0.5 0.6 |
| Height (mm) | 0.7 0.9 1.1 1.3 | 0.7 0.9 1.1 1.3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Nr. of revolutions in 100/min. | 12 | 6 12 | 6 | 6 8 10 12 14 | 2 3 4 5 6 | 5 | 12 |
| Time (sec) | 0.4 0.7 1.0 | 0.7 | 0.7 | 0.7 | 0.4 0.7 1.0 | 1.0 | 0.7 |
| Profile of tool | A | A | A | A | A | A | A,B,C |

**Table III—Selection of Initial Experiments Proposed by a Class of Advanced Students**

| Factor | Number of levels | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Material | | 2 | 2 | | 4 | 2 | | | |
| Diameter | | 2 | 2 | 4 | | | | 2 | |
| Wall thickness | 2 | | 2 | 2 | 2 | 2 | x | 2 | |
| Height | 2 | | 2 | 3 | | 2 | x | 2 | 4 |
| Amount of play | | | 2 | | | | x | 2 | |
| Profile of tool | | | 2 | | 2 | 2 | | | |
| Speed of rotat. | 2 | 2 | 2 | | 2 | | | 2 | |
| Time | | | 2 | | | | | 2 | 3 |
| Lubricant | | 2 | 2 | | 2 | | | | |
| Replications | 10 | | | 3 | 2 | 2 | | | 5 |
| Design | $2^3$ | $2^4$ | $\frac{1}{4}2^6$ | Fact. | $4.2^4$ | L. Sq. | Seq. | $\frac{1}{2}2^5$ | 3.4 |
| Design Nr. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Nrs. 1, 2, 4, 5, 9 are complete factorial designs; 3 and 8 fractional factorial designs. Design 6 consisted of two Latin squares, and Nr. 7 proposed to investigate the three factors indicated one by one. Nr. 9 is the design we actually adopted.

### Experiment I

The results of this first experiment are reproduced in Table I. These data speak for themselves. It is evident that time is comparatively unimportant, while height has a pronounced influence; when the height is too large the tensile strength goes down, the appearance deteriorates and the spread between the observations increases. Since the time used in the factory is generally about 0.7 sec this value was adopted in the next experiments; 0.9 mm appeared to be a suitable height.

### Experiment II

In designing further experiments the interactions expected between some factors were of decisive importance. A marked interaction is to be expected between wall thickness, W, and height, H, because the product WH determines the total amount of material to be deformed.

Hence the second experiment was mainly intended to study this interaction and find the best combination of wall thickness and

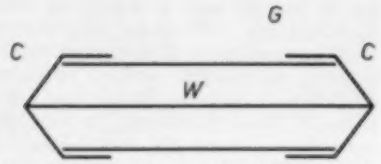


Figure 2—Construction of a Fuse for Small Currents

height, four levels were used for each of these factors. Originally an interaction was also thought conceivable between time and speed of rotation. Since in the first experiment time had been found unimportant, it now became likely that speed of rotation might also be of secondary interest. As this factor could be very easily varied it was simultaneously tested at two levels in the second experiment.

A wall thickness of 0.6 mm combined with a height of 0.9 mm turned out to be the best combination. Contrary to expectation results were much worse with 1200 than with 600 revolutions per minute. The data for the higher speed were, however, at variance with those of the first experiment and it was considered possible that some outside disturbance had occurred.

Thus we continued. Table II gives a complete survey of the series of experiments performed. The logic behind it was as follows:

**Experiment III**

Having found for Steel I a suitable combination of height, wall thickness, time and speed of rotation, this combination was now tried out for all 4 materials. Results were quite satisfactory.

The magnitude of differences between batches of the same material was simultaneously investigated, the differences were small and technically of no interest.

**Experiment IV**

Because of the bad results for 1200 revolution/minute in Experiment II the effect of the speed of rotations was once again extensively tested with all four materials. This factor appeared to have little influence and the result of Experiment II was therefore definitely attributed to some disturbance.

**Experiment V**

Large diameters. The profile of the tool was kept unchanged but the central spindle increased in diameter. This led at once to the desired results. Also an interaction with time and speed of rotation was considered possible; it may be advisable at larger diameters to use a lower speed and a longer time. Hence time and speed were again varied in this experiment.

**Experiment VI**

The conditions for larger diameters were tested on all four materials.

**Experiment VII**

Investigation of the smallest diameter in use. In this case, materials, wall thickness and the shape of the tool were the factors varied.

**Comments**

This example provokes the following comments:

1) In situations like the one here considered, where experiments are fairly simple and can be performed in a relatively short time, a series of simple experiments is more efficient than one complex experiment.

2) I once presented the problem of the swaged joints to a class of advanced students and asked them to design a first experiment. Table III gives a selection out of the answers received. Most students came up with $2^n$ factorial experiments of some kind or other including from three to nine factors at once. I am inclined to call this typical text book designs. These disregard some points of considerable interest in practice.

   We can, for example, predict beforehand that the properties of the swaged joints will show an optimum as a function of some of the factors. Two levels for such factors is not enough; three or four levels are needed.

   Also, some factors can be much more easily varied than others. It is always advisable to start off with some factors which can be easily varied, and to proceed to the more troublesome variations after we have gained some experience.

3) Not once in this series of experiments have we had recourse to sophisticated techniques as the analysis of variance or regression analysis. Simple tables with averages provided all the information required. In my view the importance of the analysis of variance is much overdone in text books on statistics.

***Example II — Fuses***

Fig. 2 depicts a small fuse of the type used to protect electric currents against an overload. A piece of glass tubing G is closed at both ends by brass caps C. Connected between the caps is the fuse wire W, which blows when the current becomes too high.

A committee established to standardize fuse specifications discovered that the properties of a fuse depended on the type of current (AC or DC) and on

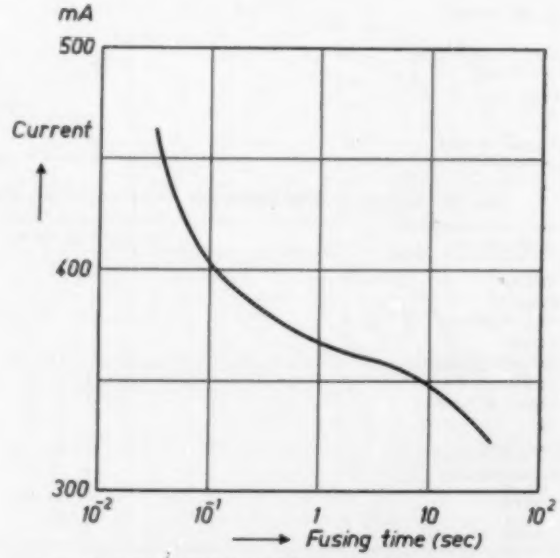


Figure 3—Indicating the General Shape of the Relation Between Current and Fusing Time

various other factors. Experiments to find out the nature of these influences were considered desirable.

The following factors and measurements were reported as being of interest.

**Factors for Fuses**

1. M, Material of the fuse wire: silver, nickel, silver-nickel, nickel-chromium.
2. D, Diameter of the wire,
3. L, Length of the wire,
4. E, Environment of the wire: air or sand,
5. F, Current frequency,
6. DG, Diameter of the glass tubing,
7. WG, Wall thickness of the glass tubing; probably unimportant.

**Observations**

The fusing time, that is the time required to blow the fuse, is observed as a function of the current. The general shape of the relation between current and fusing time is as shown in Fig. 3.

At first glance the situation may seem much the same as in the previous example. There exist, however, some important differences. Factors like the environment of the wire, the type of material, and wire diameter are certain to have a very pronounced influence. But just for that reason I would hesitate to include them in a statistically designed experiment. The interpretation of such experiments is generally based on simple additive models which are likely to fail when the effects observed are large. Variations in one experiment of the factors just mentioned would probably lead to interactions of a high order which it is almost impossible to interpret in a technological sense. The factors enumerated by the technologists are by no means factors which should always all be included in an experiment and a purposeful selection is one of the tasks with which statisticians are confronted in practice. With the fuses, experiments with one environment, one material and one diameter, and variations in length of wire, frequency, and diameter of tubing would seem to me the best approach.

But this was not what we did. For when we asked: "How large is the spread between repeated observations" the answer was "Oh, very large, but we do not know precisely." This prompted us to proceed even more cautiously, and before introducing changes in the fuses themselves, first to investigate the spread in detail. Random groups of 50 fuses from a large batch of an existing product were all blown at the same current; at lower currents where the fusing times are comparatively longer, a smaller number of observations was made. The results were reported in the shape of Fig. 4, where the average, the maximum and the minimum fusing times have been plotted. This figure was accompanied by tables with the original data. It will be noted that for high and for low currents the spread is comparatively small, but for intermediate currents it is large.

When we had a closer look at the data, we found, however, that Fig. 4 is misleading. When we plotted the individual observations instead of averages we arrived at the picture of Fig. 5. At 400 mA the distribution is clearly bimodal and instead of one continuous curve as drawn in Fig. 4 we must distinguish two separate branches.

Having observed this, it was not difficult to find a technical explanation. At 400 mA the fusing wire reaches a temperature near to its melting point; owing to the unavoidable spread in quality some fuses will actually be heated above this temperature and blow almost at once, while others stay below the melting point and will only blow by oxidation which is a slower process. Hence the two branches may be designated as the melting branch and the oxidation branch.

This also explains the difference between AC and DC. AC produces periodic fluctuations in the temperature, and the peak temperature with AC is consequently higher than the temperature reached with an equal DC. The transition from oxidation to melting

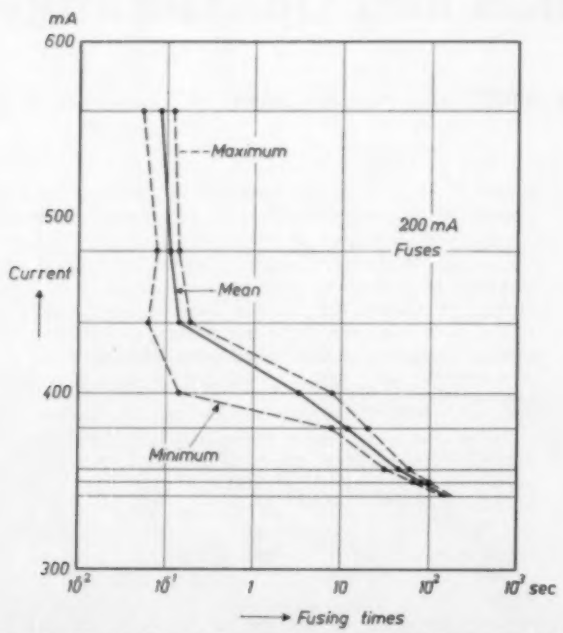


Figure 4—Results of Repeated Observations with 200 mA Fuses as Reported

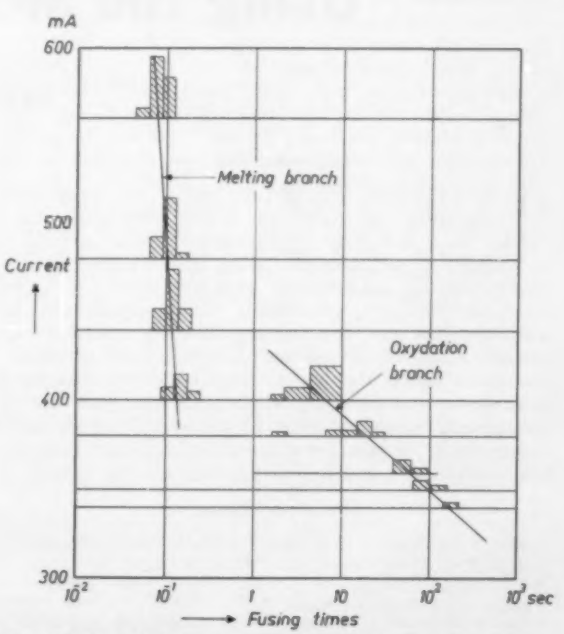


Figure 5—Presentation of the Data of Fig. 3 in the Form of Histograms

will take place at a lower current with AC than with DC.

No further experiments were required. Obviously the fact that two distinct processes are involved, which had never been noticed before, is of considerable importance in setting up specifications and the entire problem had to be studied from a new angle.

An excerpt of the original data is presented in Table IV. It is worth mentioning that engineers

**Table IV—Some of the Fusing Times Observed**

| Current | Fusing times in millisec. | | | | |
|---|---|---|---|---|---|
| 380 mA | 1327 | 995 | 928 | 910 | 538 |
| | 382 | 1012 | 801 | 323 | 586 |
| 400 mA | 340 | 314 | 226 | 351 | 425 |
| | 10 | 8 | 264 | 14 | 270 |
| | 7 | 213 | 11 | 171 | 287 |
| | 7 | 307 | 402 | 10 | 219 |
| 440 mA | 8 | 3 | 6 | 6 | 6 |
| | 5 | 6 | 5 | 5 | 7 |

without statistical training, who have only dealt with well-behaved observations that can be adequately represented by the average, can easily overlook situations that give rise to a bimodal distribution where the average is no longer appropriate.

### Conclusion

These two examples raise the question: What exactly is the role a statistician should play in designing experiments? There exist situations no doubt where a sophisticated statistical design is necessary to satisfactorily answer a technical problem. But in many other cases simple, almost common-sense arguments and experiments may suffice. Yet here, too, the role of the statistician is an important one because, in either case, it is the statistical outlook and approach which is essential.

With the swaged joints, for example, many unsuccessful experiments had been made before the statistician was consulted, while his experiments were almost immediately successful. I believe it is the statistical logic which is mainly responsible. All too often the experimenter without statistical training unconsciously confounds some factors in his experiments and if this is purposely avoided the interpretation of the results at once gains in clarity and conclusiveness. Another important factor has been that in designing the series of experiments described in Example I, conceivable interactions were carefully taken into account.

In the case of the fuses the peculiar shape of the curve in Fig. 3 and the lack of information on the spread in repeated observations gave us right at the outset an uncertain feeling which prompted a more careful procedure, with the result described in Example II. Perhaps here one of the most important factors was that the statistician as an outsider had no preconceived ideas and was much more capable of objectively appraising the situation than was the physicist or engineer who had been experimenting with fuses for many years.

Anyhow, a careful analysis of the situation should always precede the actual designing of an experiment, and in many cases this is perhaps the most important part of a successful design. This aspect is not in our opinion sufficiently emphasized in textbooks on the subject.

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# Lot Acceptance Sampling by Variables Using the Median and Quasi-Range

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### Introduction

ONE MAJOR DISADVANTAGE of acceptance sampling by variables is the time-consuming calculations involved. The purpose of this article is to present a variables sampling plan which requires practically no calculations and yet which provides adequate sampling protection. This purpose will be accomplished by substituting sample median and sample quasi-range for the statistics used in other* variables sampling plans. The variables sampling plan presented here will deal only with the case of single-sided specifications. Plans which handle two-sided specifications have been derived and used by the author but are not presented in this article.

### The Quasi-Range

For a sample of size n, the i-th quasi-range ($QR_i$) is defined as follows:

$$QR_i = X_{n+1-i} - X_i, \quad i > 0$$

where $X_1, X_2, \ldots X_n$ are ordered values in a random sample of size n chosen from a population which is normally distributed. It is readily seen that $QR_1 = (X_n - X_1)$ is the difference between the largest and smallest observations in a sample, or as it is more familiarly called, $QR_1$ is the sample range. $QR_2 = (X_{n-1} - X_2)$ is seen to be the difference between the second largest and the second smallest observations in a sample; $QR_3$, $QR_4 \ldots QR_i$ follow in a like manner.

Since there is more than one quasi-range per sample, consideration must be given to the question of which quasi-range should be used for a given sample size. Cadwell[3] shows that for $18 \leq n \leq 31$, $QR_2$ is the most efficient quasi-range for estimating population standard deviation. For $32 \leq n \leq 50$, he shows that $QR_3$ becomes the most efficient quasi-range. This article will consider only sampling plans whose sample sizes are on or between 20 and 50 (in steps of 5), hence, on the basis of efficiency, $QR_2$

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*See Reference 1 for variables plans using the sample average and sample mean range and Reference 2 for plans using the sample average and sample standard deviation.

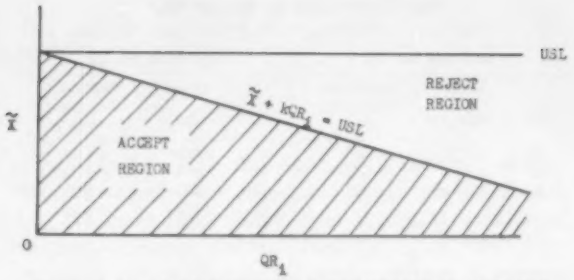



**Figure 1—Accept-Reject Graph for Upper Specification Limit Only**

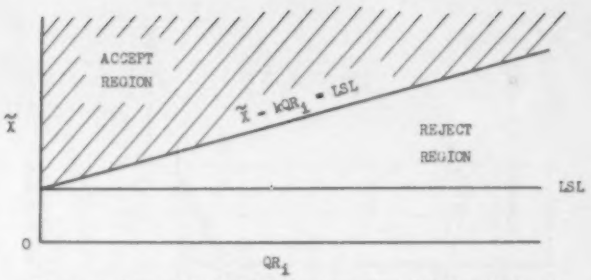



**Figure 2—Accept-Reject Graph for Lower Specification Limit Only**

will be used for $n = 20$, 25, and 30 and $QR_2$ for $n = 35$, 40, 45, and 50.

Even the most efficient quasi-range isn't as efficient as either the sample standard deviation or the sample average range. It should be recognized, therefore, that substituting quasi-range for either of these two statistics buys the convenience of simplified calculations at the price of reduced sampling protection. The amount the sample protection is reduced is measurable, however, and will be more fully discussed in the section on Operating Characteristic Curves. It is up to the user, then, to determine if the reduction in sampling protection is worth the gain in work simplification.

### *The Median*

For a sample size n, the median ($\tilde{X}$) is defined as the value of the middle X when each of the values for X in the sample are arranged in order of magnitude. If n is even there is no single central X and the median is the arithmetic average of the two middlemost values.

### *Sampling Criteria — One Sided Protection*

When there is only one specification limit, the criteria governing acceptance or rejection are as follows: (USL = upper specification limit, LSL = lower specification limit):

$$\text{Accept if } \tilde{X} + k\,QR_i \leq USL$$

$$\text{Reject if } \tilde{X} + k\,QR_i > USL$$

(Applicable when only an upper limit is specified) or,

$$\text{Accept if } \tilde{X} - k\,QR_i \geq LSL$$

$$\text{Reject if } \tilde{X} - k\,QR_i < LSL$$

(Applicable when only a lower limit is specified)

In the above equations, k is a constant which is dependent upon both sample size and AQL. The method for computing k will be shown in a later section of this article.

### *Sampling Criteria in Graphical Form*

The sampling criteria shown in the preceding section are based on sample statistics which require practically no calculations (i.e., both median ($\tilde{X}$) and quasi-range ($QR_i$) are usually found by inspection once the data have been arranged in order of magnitude). However, there still remains the calculations involved in evaluating the inequalities which form the acceptance-rejection criteria. Fortunately, these calculations may be eliminated by transforming all of the inequalities into graphs which automatically make the accept-reject decision. Thus, it is proposed that in its final format the sampling procedure will work as follows:

1. Obtain a random sample of the required size from the lot.
2. Read each piece in the sample for the inspection characteristic.
3. Record the measurements in histogram form (the histogram cell interval must be equal to the measurement accuracy).
4. Obtain the median ($\tilde{X}$) and the applicable Quasi-Range ($QR_i$) from the completed histogram.
5. Using the values obtained for Median and Quasi-Range as ordinate and abscissa, respectively, plot a point on the Accept-Reject Graph. If the plotted point lands in the "accept" region, accept the lot, if it lands in the "reject" region, reject the lot.

Fig. 1 and 2 illustrate the construction of two typical Accept-Reject Graphs.

### *Distributions of $\tilde{X}$ and $QR_i$*

The distribution of $QR_i$ can be shown[3] to be adequately described by the normal curve for all practical purposes for the sample sizes in which we are interested. Cadwell provides percentage points for the distribution of $QR_2$* for sample sizes 10 through 30. These can be compared to the percentage points obtained if one assumes $QR_2$ to have a normal distribution. Such a comparison was made for $n = 20$, 25, and 30, and the differences were found to be negligible (in all cases not greater than one percent), thus $QR_2$ is shown to be adequately described by the normal distribution. Unfortunately, Cadwell does not provide similar percentage points for the distribution of $QR_3$*. However, a careful reading of Cadwell's paper and an examination of the probability density function he provides for $QR_1$* leads one to the conclusion that since $QR_2$ is very nearly normally distributed for $n = 20$, 25, and 30, $QR_3$ would be even more normally distributed for $n = 35$, 40, 45, and 50.

The means and standard deviations of $QR_2$ and $QR_3$ are shown in Table I. The constants for $QR_2$ and $QR_3$ were obtained from an article[4] entitled "Acceptance Sampling of Lots by the Median, Quasi-Range Method" *Industrial Quality Control*, July, 1958.

For the sample sizes being considered, the distribution of the median also follows the normal curve

*The nomenclature used in this article to designate the various quasi-ranges differs somewhat from that employed by Cadwell. He designates the $r^{th}$ quasi-range as $W_r = X_{n-r} - X_{r+1}$. Thus, $W_0$ in Cadwell's paper is $X_n - X_1$, which corresponds to $QR_1$ in this article. Similarly, $W_1 = QR_2$, $W_2 = QR_3$, etc. The percentage points Cadwell provides for the distribution of $W_r$, therefore, are also percentage points for the distribution of $QR_{r+1}$, since $W_1 = QR_2$.

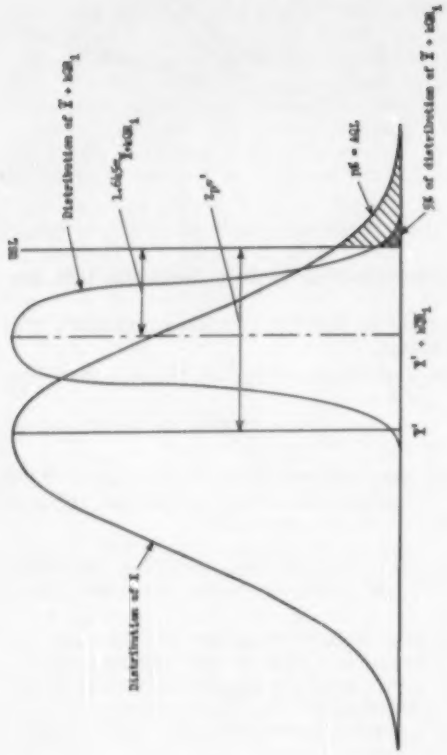



Figure 4—Relationship Between Distribution of $\bar{X}$ and $\tilde{X} + kQR_1$

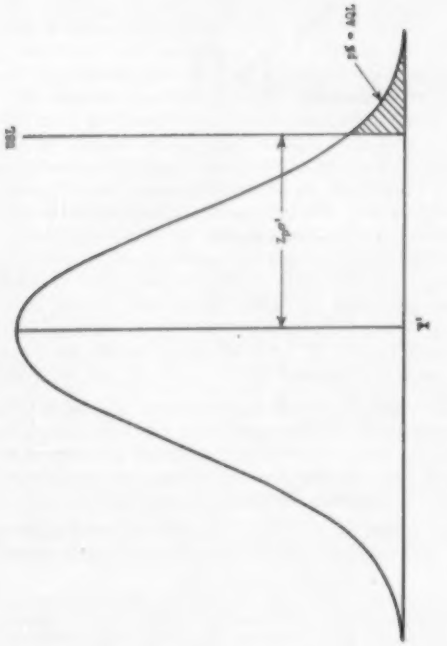



Figure 3—Illustration of an Acceptable Lot where the Specification is One-Sided and AQL is the only Criterion

**Table I—Constants for $QR_2$ and $QR_3$***

| Constants for $QR_2$ | | | Constants for $QR_3$ | | |
|---|---|---|---|---|---|
| n | Mean ($\overline{QR_2}$) | Standard Deviation ($\sigma_{QR_2}$) | n | Mean ($\overline{QR_3}$) | Standard Deviation ($\sigma_{QR_3}$) |
| 20 | $2.815\sigma'$ | $0.538\sigma'$ | 35 | $2.895\sigma'$ | $0.422\sigma'$ |
| 25 | $3.049\sigma'$ | $0.522\sigma'$ | 40 | $3.034\sigma'$ | $0.414\sigma'$ |
| 30 | $3.231\sigma'$ | $0.509\sigma'$ | 45 | $3.153\sigma'$ | $0.407\sigma'$ |
| | | | 50 | $3.257\sigma'$ | $0.461\sigma'$ |

*If population is normally distributed.

providing the population being sampled is normally distributed. The means and standard deviations of the sample medians are shown in Table II. The standard deviation of the median was obtained from Reference 4.

### *Distribution of $\tilde{X} + k(QR_1)$*

Since $\tilde{X} + k(QR_1)$ is a linear combination of independent variables, both of which possess normal distributions, the distribution of $\tilde{X} + k(QR_1)$ is also normal, with mean $\bar{X}' + k(\overline{QR_1})$ and standard deviation $\sqrt{\sigma^2_{\bar{x}} + k^2\sigma^2_{QR_1}}$

### *Derivation of "k"*

Where there is only one limit on the inspection characteristic, and where the AQL is p percent, an acceptable lot is one which satisfies one of the following inequalities, whichever is applicable:

$$\bar{X}' + Zp\sigma' \leq USL \qquad (1)$$

or

$$\bar{X}' - Zp\sigma' \geq LSL \qquad (2)$$

In the above inequalities, $\bar{X}'$ designates the lot average, $\sigma'$ designates the lot standard deviation, USL and LSL designate the upper and lower specification limits respectively, and Zp designates the normal deviate associated with a tail area of p percent. Graphically, an *acceptable* lot may be shown as in Fig. 3.

Since the lot shown in Fig. 3 represents one whose percent defective (p) is exactly equal to the AQL, the sampling plan should accept such a lot most of the time. In this article, such a lot will be accepted 95 percent of the time. Further, since the statistic used to determine lot acceptability is $\tilde{X} + k(QR_1)$, the distribution of $\tilde{X} + k(QR_1)$ should be such that 95 percent of it is within the specification limit when (1 — p) percent of the lot is within the specification limit. Algebraically, this may be stated as follows. When

$$\bar{X}' + Zp\sigma' = USL \qquad (3)$$

then we want

$$\bar{X}' + k(\overline{QR_1}) + 1.645\sigma_{\bar{x}+k(QR_1)} = USL \qquad (4)$$

Graphically, this may be shown as in Fig. 4. Both (3) and (4) equal the same thing, therefore they are equal to each other, as follows:

$$\bar{X}' + Zp\sigma' = \bar{X}' + k(\overline{QR_1}) + 1.645\sigma_{\bar{x}+k(QR_1)} \qquad (5)$$

As mentioned previously, $\sigma_{\bar{x}+k(QR_1)} = \sqrt{\sigma^2_{\bar{x}} + k^2\sigma^2_{QR_1}}$, therefore (5) becomes (with reductions)

$$Zp\sigma' = k(\overline{QR_1}) + 1.645\sqrt{\sigma^2_{\bar{x}} + k^2\sigma^2_{QR_1}} \qquad (6)$$

Squaring both sides of (6) and collecting terms,

(6) may be rewritten as a quadratic equation in k. Thus

$$k = \frac{Zp\sigma'(\overline{QR}_i) \pm 1.645 \sqrt{\overline{QR}_i^2 \sigma^2_{\tilde{x}} + (Zp)^2(\sigma')^2\sigma^2_{QR_i} - (1.645)^2\sigma^2_{QR_i}\sigma^2_{\tilde{x}}}}{\overline{QR}_i^2 - (1.645)^2\sigma^2_{QR_i}} \quad (7)$$

All the terms in the right-hand member of (7) are dependent upon either sample size or AQL, and are available from Tables I and II plus a table of normal deviates. (When substituting in (7) from Tables I and II, it will be observed that $\sigma'$ cancels out entirely.) For a given sample size and AQL, therefore, (7) will provide a solution for k. When solving (7), the negative square root of the quantity under the radical should be used. The general rule is that if the probability of acceptance associated with p is greater than 0.5, the negative root should be used; if the probability of acceptance associated with p is less than 0.5, the positive root should be used. In this case, p is the AQL and the probability of acceptance will be 0.95, hence the negative root provides the correct solution.

For example, let the AQL = 4 percent and the sample size = 30. From a table of normal deviates, $Zp = 1.75$ for $p = 4$ percent, and $P_a = 0.95$. From Table I, it is seen that $QR_2$ should be used for $n = 30$. From Tables I and II, when $n = 30$, $\overline{QR}_2 = 3.231\sigma'$, $\sigma_{QR_2} = 0.509\sigma'$ and $\sigma_{\tilde{x}} = 0.224\sigma'$. Substituting these values in (7), one obtains

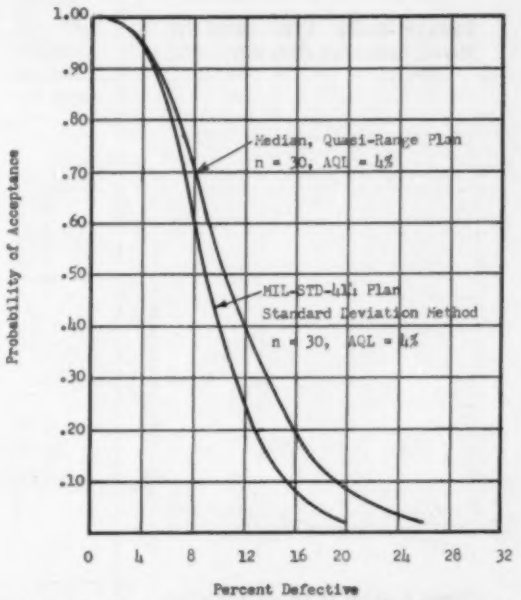



**Figure 5—Comparison of OC Curve of Median, Quasi-Range Sampling Plan with that of Corresponding MIL-STD-414 Plan (Plans Correspond as to Sample Size and AQL)**

$$k = \frac{1.75\sigma'(3.231\sigma') - 1.645\sqrt{(3.231\sigma')^2(0.224\sigma')^2 + (1.75)^2(\sigma')^2(0.509\sigma')^2 - (1.645)^2(0.509\sigma')^2(0.224\sigma')^2}}{(3.231\sigma')^2 - (1.645)^2(0.509\sigma')^2}$$

$$= 0.39$$

### *Operating Characteristic Curves*

From Fig. 4, it is apparent that to determine the probability of acceptance ($P_a$) for a given percent defective (p percent), one merely determines how much of the distribution of $\tilde{\overline{X}} + k(QR_i)$ lies to the left of USL. Using the area under the normal curve tables contained in Grant[5], one proceeds as follows:

let $X_i = USL = \overline{X}' + Zp\sigma'$

$$\overline{X} = \overline{X}' + k(\overline{QR}_i)$$

$$\sigma = \sqrt{\sigma^2_{\tilde{x}} + k^2\sigma^2_{QR_i}}$$

Then

$$Z_{P_a} = \frac{X_i - \overline{X}}{\sigma} \quad (8)$$

Substituting for $X_i$, $\overline{X}$, and $\sigma$, (8) reduces to

$$Z_{P_a} = \frac{Zp\sigma' - k(\overline{QR}_i)}{\sqrt{\sigma^2_{\tilde{x}} + k^2\sigma^2_{QR_i}}} \quad (9)$$

In (9), $Z_{P_a}$ is the normal deviate which yields the percentage of the distribution of $\tilde{\overline{X}} + k(QR_i)$ which is below USL. This percentage, of course, is the probability of acceptance ($P_a$) for a given percent defective (p percent).

To illustrate the computations involved, suppose a sampling plan has been devised for a 4 percent AQL and sample size 30, and that it is desired to compute the probability of acceptance for a lot ten percent defective. In the section "Derivation of k," it was determined that when $n = 30$, $QR_2$ is used and that for a 4 percent AQL, $k = 0.39$. Further, for a tail area (p) of 10 percent, $Z_{0.10} = 1.28$ and from Tables I and II, $\overline{QR}_2 = 3.231\sigma'$, $\sigma_{\tilde{x}} = 0.224\sigma'$ and $\sigma_{QR_2} = 0.509\sigma'$. Substituting in (9), one obtains

$$Z_{P_a} = \frac{1.28\sigma' - 0.39(3.231\sigma')}{\sqrt{(0.224\sigma')^2 + (0.39)^2(0.509\sigma')^2}}$$

$$= +0.067$$

For a normal deviate of +0.067, Grant's[5] tables yield a tail area of 52.67 percent. Thus, for

**Table II—Standard Deviation of the Sample Median***

| n | $\sigma_{\tilde{x}}$ |
|---|---|
| 20 | $0.271\sigma'_x$ |
| 25 | $0.248\sigma'_x$ |
| 30 | $0.224\sigma'_x$ |
| 35 | $0.211\sigma'_x$ |
| 40 | $0.195\sigma'_x$ |
| 45 | $0.186\sigma'_x$ |
| 50 | $0.175\sigma'_x$ |

*If population is normally distributed

Figure 6—Family of OC Curves for Median, Quasi-Range Plans (AQL = 4%)

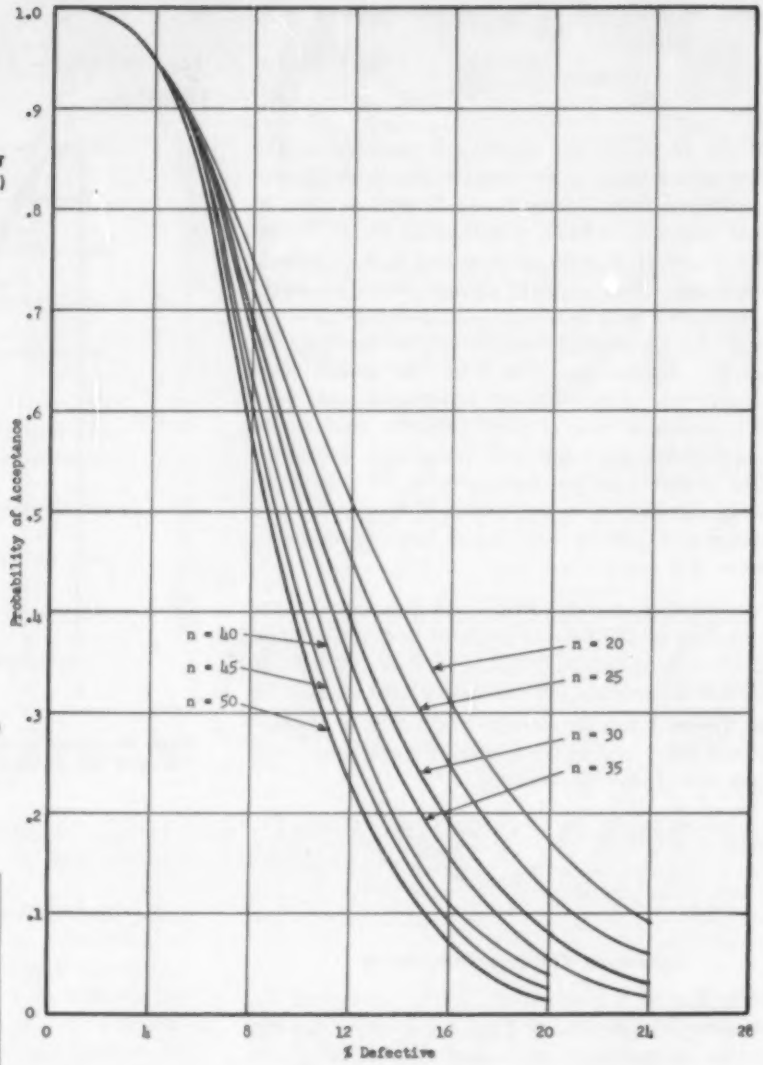
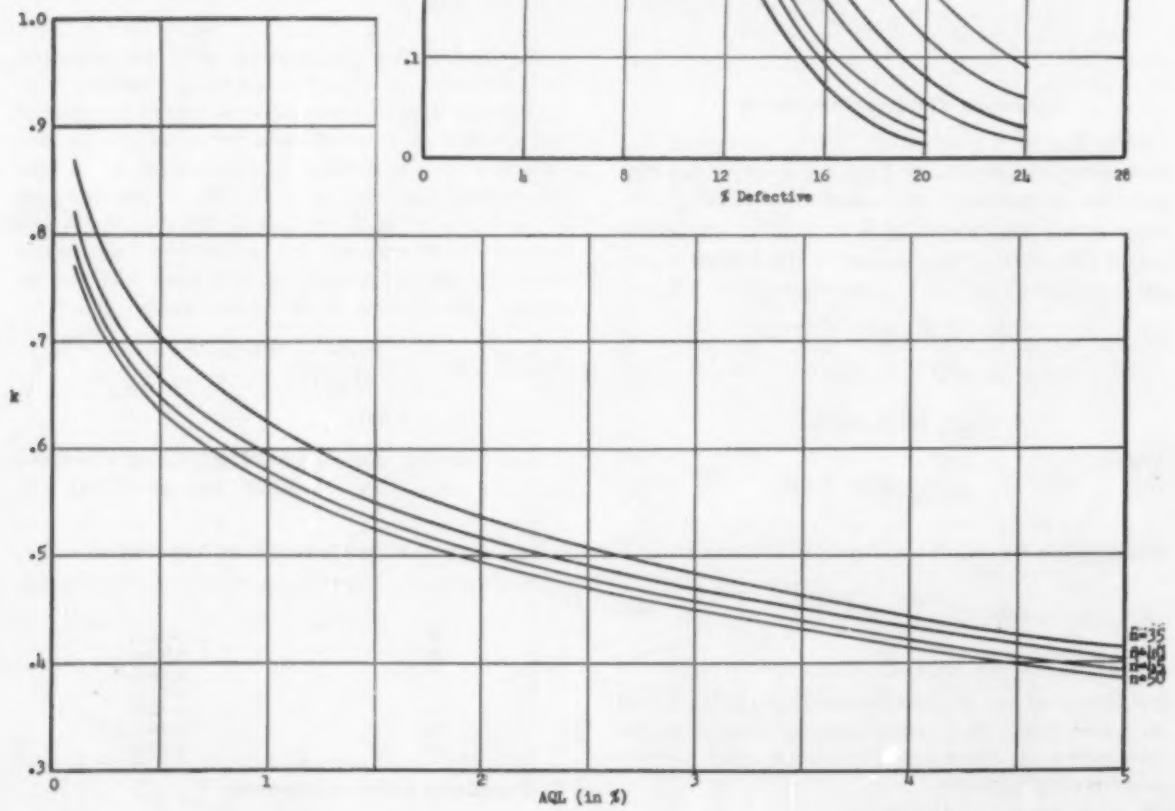



Figure 7—Graph of AQL vs. k (n given)



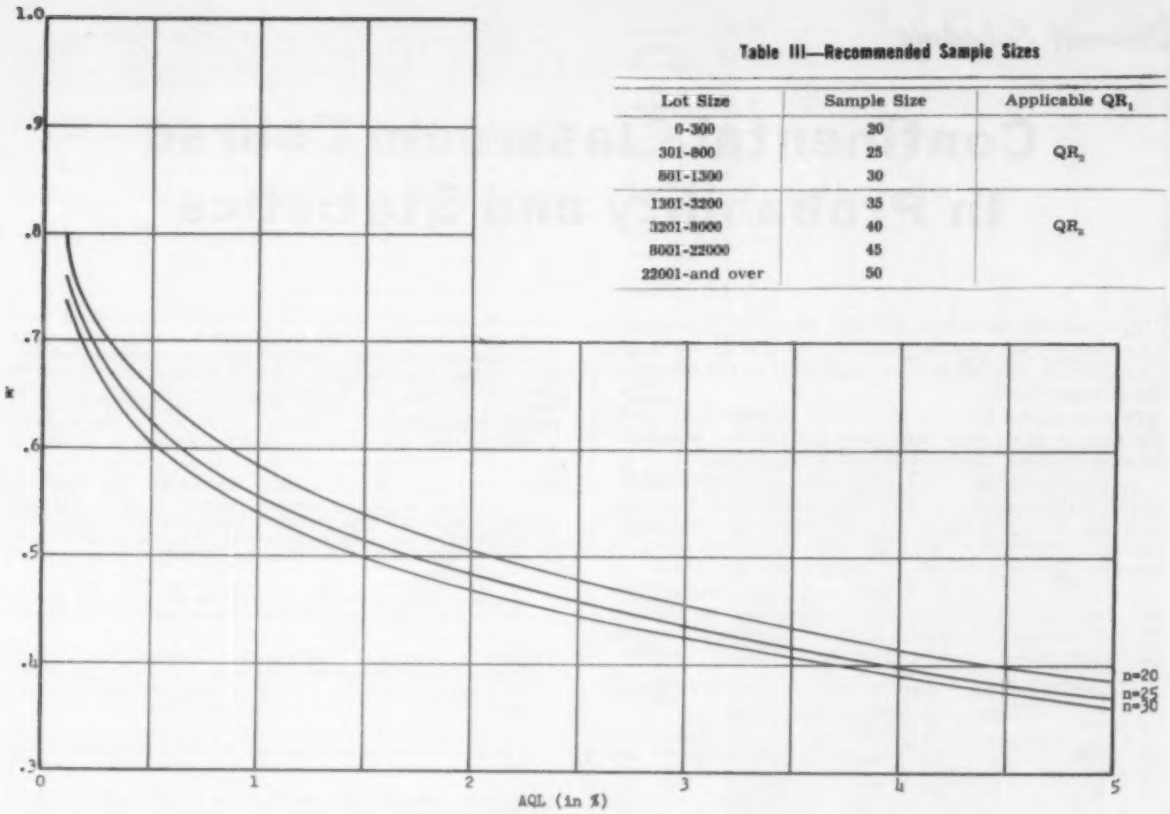



**Figure 8—Graph of AQL vs. k (n given)**

**Table III—Recommended Sample Sizes**

| Lot Size | Sample Size | Applicable $QR_1$ |
|---|---|---|
| 0-300 | 20 | |
| 301-800 | 25 | $QR_2$ |
| 801-1300 | 30 | |
| 1301-3200 | 35 | |
| 3201-8000 | 40 | $QR_3$ |
| 8001-22000 | 45 | |
| 22001-and over | 50 | |

a percent defective (p) of 10 percent, the probability of acceptance ($P_a$) is 52.67 percent. Continuing in the same manner, the complete Operating Characteristic Curve was computed and is shown in Fig. 5. For purposes of comparison, Fig. 5 also shows the OC Curve for the corresponding MIL-STD-414 plan. (The MIL-STD-414 plan chosen corresponds with the Quasi-Range plan in AQL 4 percent and sample size 30.)

From Fig. 5, it is apparent that the Quasi-Range plan provides somewhat less protection for the consumer than does the corresponding MIL-STD-414 plan. It is left to the individual to decide whether this increase in sampling risk is justifiable by the very real reduction in required calculations. It has been the author's experience that the incurred loss in consumer sampling protection is far outweighed by the gain in work simplification.

### *Choosing a Particular Sampling Plan*

The choice of a particular sampling plan, given the AQL, should be based primarily on the degree of sampling protection desired. Since this article considers only sampling plans with sample sizes on or between 20 and 50, the OC Curves need be computed only for seven sample sizes. The sample size whose OC Curve most nearly fits the desired sampling protection is the one used.

As an illustration, suppose a sampling plan is desired with an AQL of four percent and an LTPD of approximately 18 percent. The OC Curves for the seven available sampling plans (n = 20, 25, 30, 35, 40, 45, and 50) are shown in Fig. 6. It is apparent that n = 35 most nearly matches the AQL and LTPD desired.

For those who prefer relating the sample size to the lot size, Table III provides the sample size versus lot size relationship recommended by the author. Table III also indicates which $QR_1$ is applicable for each sample size.

Values of k have been computed for AQL's up to five percent and are shown graphically on Figs. 7 and 8.

### *References*

1. Harold J. Gulde, "Acceptance Sampling by Variables Using The Range," *Industrial Quality Control*, Vol. X, No. 3, November, 1953, p. 18-25.

2. A. Bowker and H. Goode, *Sampling Inspection by Variables*, McGraw-Hill Book Co., Inc. 1952.

3. J. H. Cadwell, "The Distribution of Quasi-Ranges in Samples from a Normal Population," *Annals of Mathematical Statistics*, Volume 24, No. 4, December, 1953.

4. JETEC-11, Committee on Sampling Procedures, "Acceptance Sampling of Lots by the Median, Quasi-Range Method," *Industrial Quality Control*, Volume XV, No. 1, July 1958, p. 8-11.

5. E. L. Grant, *Statistical Quality Control*, McGraw-Hill Book Co., Inc. New York, N.Y., 1952.

*Current Schedule*

# Continental Classroom Course In Probability and Statistics

This current schedule includes Chapters 7 through 9, Lessons 34-48, April 24-May 26.

Chapters 1 through 6 were published in the January and February issues.

This Continental Classroom course in probability and statistics is being presented from 6:30-7 a.m., Mondays through Fridays, over the NBC TV Network.

Arrangements for the course were made by Paul C. Clifford, director of the ASQC Education and Training Institute, in cooperation with Dr. Frederick Mosteller, Harvard University. Mr. Clifford is a professor at Montclair State Teachers' College, Montclair, N.J.

For additional information, consult the January issue, *Industrial Quality Control*, pages 5-7, or contact Dr. John J. Kelley, National Coordinator, Continental Classroom, 680 Fifth Ave., New York 19, N.Y.

**CHAPTER SEVEN — Repeated Trials with Two Types of Outcomes — The Binomial Distribution**

In an investigation, we may study only the presence or absence of some specific characteristic. In this chapter, we are concerned with independent repetitions of trials with two outcomes, usually called "success" and "failure." The study of these *binomial* experiments allows us to answer a great many questions that not only have practical but also theoretical significance. Indeed, our study will culminate in the formulation of an important theorem which, because of its central position in the theory of probability, is known as the central limit theorem. At the end of this chapter, we discuss a special case of this theorem, leaving the more general statement of the theorem for Chapter 9.

**LESSON 34, Apr. 24 — Binomial experiments.** The binomial distribution as a mathematical model of wide practical applicability and with important theoretical properties. Some examples of binomial experiments. Four basic assumptions underlying binomial experiments. Experiments with three thumbtacks.

After some introductory examples, we state and discuss the precise conditions that characterize the binomial model.

**LESSON 35, Apr. 26 — The binomial distribution for n trials.** The probability of exactly x successes in n trials. Relationship to binomial expansion. Batting averages and hits. Are two-engine planes safer than four-engine planes?

This lesson deals primarily with the derivation and application of the general formula for the probability of observing a given number of successes in n trials.

**LESSON 36, Apr. 28 — Expected value of a binomial variable. Binomial probability tables.** The expected number of successes. Mean values and actual observations. Aids to computation: table of individual binomial probabilities, table of cumulative binomial probabilities. Range and accuracy of tables. Interpolation.

The formula for the probability of observing a given number of successes is important primarily for theoretical reasons. If the number of trials is not small, the computational work involved in evaluating such probabilities makes direct use of the formula impractical. Two possibilities exist: to use prepared tables or to use approximate methods of evaluation. In this lesson, we discuss tables. In future lessons, we discuss how the normal distribution can be used to approximate binomial probabilities.

The binomial distribution affords a major opportunity to apply what we have learned about mathematical expectation. Furthermore, the expected value of a binomial variable is needed in the work on approximations.

**LESSON 37, May 1 — Properties of the binomial distribution.** Dependence of the binomial distribution on the probability of success. Dependence of the binomial distribution on the number of trials: walking, flattening, spreading.

The binomial distribution depends on two parameters, the probability of success in a single trial and the total number of trials. We study the nature of this dependence separately for the two parameters.

**LESSON 38, May 3 — Making the binomial distribution behave.** Desirability of the normal approximation for the binomial distribution. The mechanics of the approximation: area representation of binomial probabilities, change of unit of measurement, use of normal area table.

**LESSON 39, May 5 — The central limit theorem for the binomial distribution.** Meaning of the normal approximation to the binomial distribution: visual and tabular illustrations. Accuracy of approximation.

After the toil of the previous lessons, we are ready for our reward: the formulation of the central limit theorem for the binomial distribution and an appreciation of its workings.

**CHAPTER EIGHT — Some Statistical Applications of Probability**

We investigate how probability is applied to the solution of certain problems of statistical inference. Since we have carried out a particularly detailed study of the binomial distribution, our discussion is in terms of this mathematical model. However, the methods to be discussed are of much greater generality. We

## *QC, Reliability Symposium Issues Call to Authors*

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The symposium will be sponsored by ASQC, IRE, AIEE, and EIA.

May 15, 1961, is the deadline for submission of title of paper and an abstract of not more than 800 words. The letters and spaces in the title of the paper must not exceed 50.

Submit brief biographical sketches of the author and/or authors, suitable for publication in the Proceedings.

For papers with more than one author, please indicate a single author for the presentation.

Ten copies of the abstract and biographies should be sent to E. F. Jahr, IBM Corp., Dept. 351, Owego, N.Y.

On June 30, 1961, authors will be notified of paper acceptance or rejection.

On Oct. 6, complete paper must be submitted to the Program Committee for publication in the Symposium Proceedings.

All papers must be new and not presented prior to the Symposium at a national society meeting. Papers presented at local meetings are acceptable.

work on two related problems: *estimation* and *hypothesis testing*. Each is studied first without the use of prior information as it would be treated by a statistician belonging to the objective school, and then with the use of prior information in the manner of a statistician of the personalistic school.

**LESSON 40, May 8 — Statistical inference. Estimating p, the binomial probability of success.** Two problems of statistical inference: estimation and hypothesis testing. The observed success ratio as an unbiased estimate of p. Accuracy of the estimate. Determination of sample size. Mathematical formulation of the "law of averages": the law of large numbers.

If the probability of success in a binomial experiment is unknown, it is natural to try to estimate it on the basis of experimental data. We discuss questions related to this problem of estimation, in particular, questions about the accuracy of a given estimate and the number of observations required to achieve a prescribed accuracy.

**LESSON 41, May 10 — Confidence limits for p.** The meaning of confidence limits. Large sample confidence limits for p. Charts for the determination of confidence limits.

The estimate of p discussed in the previous lesson is simple and easily understood. However, is has the disadvantage that, without supplementary information, it does not reveal its intrinsic accuracy or inaccuracy. The confidence limit approach to estimation provides a built-in measure of accuracy, the length of the confidence interval.

**LESSON 42, May 12 — Testing a binomial statistical hypothesis.** Quality control. Operating characteristic of a test. Sign test. Null and alternative hypotheses. Relation of test procedure to confidence interval approach.

The methods of estimation of the previous two lessons are appropriate if we want to get general information about the unknown probability of success of a binomial population. If, on the other hand, we want to know whether or not the performance of a binomial experiment is consistent with the assumption that the probability of success has a given value, we have the problem of testing a statistical hypothesis. Such a problem arises if we must choose one of two possible actions and if the preference for a particular action depends on the true (but unknown) value of the success probability. In this and the next lesson, we discuss the solution of such decision problems.

**LESSON 43, May 15 — Testing a binomial statistical hypothesis** (continued). One-sided tests. Descriptive level of significance. Accepting or rejecting the null hypothesis.

**LESSON 44, May 17 — Bayesian approach to estimation and hypothesis testing.** The use of prior information in the estimation of an unknown success probability. The use of prior information in testing a statistical hypothesis. Comparison with standard procedure. Difficulties of the Bayesian approach.

The estimation and test procedures of the previous lessons have to be considered in the light of the frequency interpretation of probability. Thus, probabilities associated with confidence intervals and decisions apply only to long sequences of similar confidence statements and decisions. In a personalistic approach, an attempt is made to obtain a probabilistic statement that applies to the situation at hand. Such a personalistic approach is often based on Bayes' theorem and incorporates the subjective judgement of the investigator about available prior information.

**CHAPTER NINE — Sums and Averages of Variables, The Central Limit Theorem**

We intuitively feel that the arithmetic average of several measurements is more reliable than a single measurement. In this chapter, we investigate how this intuitive feeling can be made mathematically precise. Since averages are obtained by summing the individual measurements and then dividing by the number of measurements, we start with sums of measurements.

Though we find that the derivation of the exact distribution of sums of variables usually is complicated, and extension of the central limit theorem for binomial variables allows us to compute approximate probabilities based on the standard normal distribution. Application of this central limit theorem requires only knowledge of the mean and variance of sums of random variables.

In the next three lessons, we take up the problems indicated above. From sums of variables, it is a short step to averages.

**LESSON 45, May 19 — Distribution of a sum.** Exact distribution of a sum of variables. Variance of a sum of variables.

**LESSON 46, May 22 — Variance of sums of independent variables.** More about the variance of sums. Identically distributed variables. The binomial variable as a special case of a sum of variables.

**LESSON 47, May 24 — The central limit theorem.** Formulation of the central limit theorem. Application to averages.

**LESSON 48, May 26 — Conclusion.** Summing up, review and further work.


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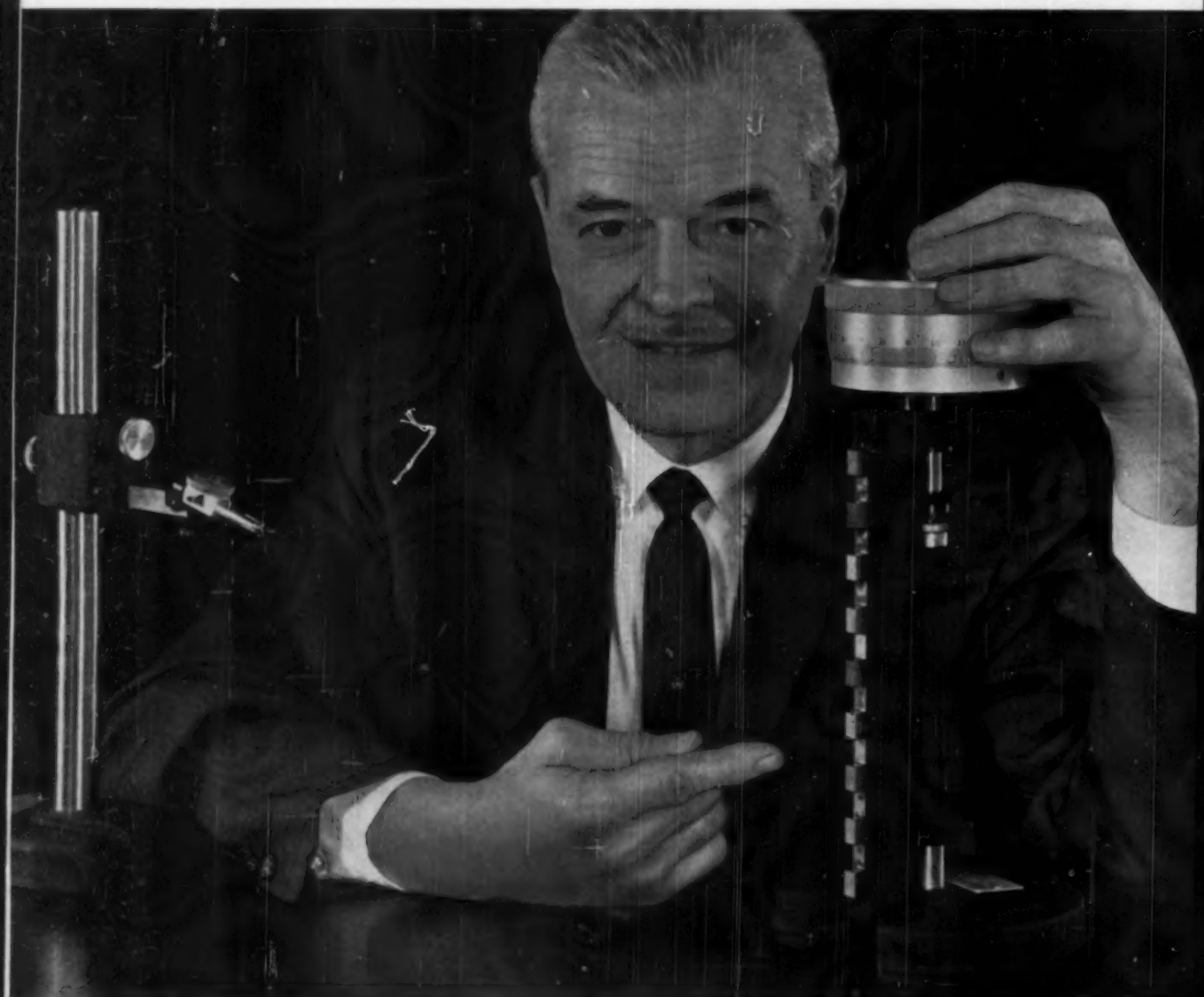

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"You see — Hite-Set has a series of half-inch precision blocks, locked in a carrier on one-inch centers. A super-accurate micrometer head moves the carrier up and down 1", and with the mike at 0.0000," the tops of the blocks are at even inches—1", 2", 3", etc., high.

"You just pick the right block — turn the head to your ten-thousandth reading. The top of the block is then at the height you want, ready for transfer. What could be quicker!

"Setting the bottom of blocks is easy, too, *without* attachments. You just subtract .5000".

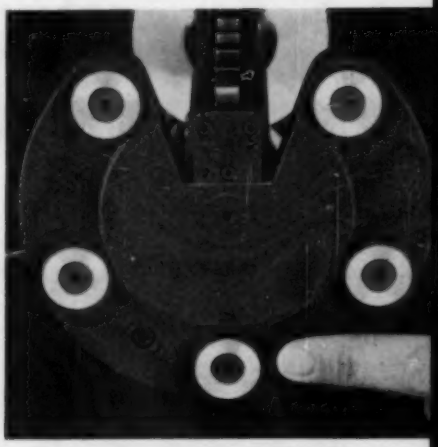
"If you want even faster setting, there's Brown & Sharpe's 'Hite-Icator'. It's a Hite-Set with a dial indicator added that shows .1", .01" and .001".

# & Sharpe's new Hite-Set tool you can buy!"

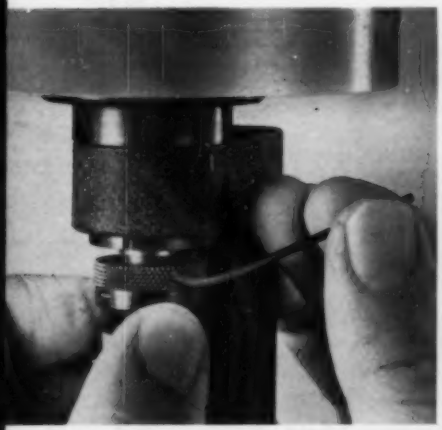
Design, Brown & Sharpe, Industrial Products Division

**"Look at this easy-reading head!** It's a full 4" across — the biggest in the business. Reads directly in tenths, and spreads the divisions out so you can see them all the way across a big surface plate or machine.

**"See the accuracy you get** — within .000050" over the entire range of blocks, and highly repeatable! You read off a small parallel surface, moving up and down, not, as in some tools, off a large rotating disk.

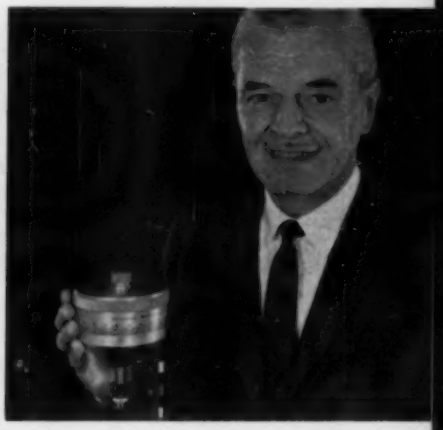


**"Base is solid as a rock!** These five big buttons are hardened and lapped to better than Class A Gage Block accuracy, so your Hite-Set won't tilt. (If it does, you need a new surface plate from Brown & Sharpe!)



**"See the simple zero adjustment** — You don't have to take the head off to set to "zero". Another feature: Repairs are economical; damaged Hite-Set blocks are replaced individually — you don't need a whole new column.

**"Companion pieces to do any job** better are available from Brown & Sharpe. Super Hite-Chek® (a) transfers heights in .000025". 9" Riser Blocks (b) extend range at low cost. B&S Black Granite plates and flats provide a perfect base.



**"Finally, you pay less for Hite-Set accuracy.** When the range of heights you want to measure is considered, you will find that combinations of Brown & Sharpe Hite-Sets and Riser Blocks usually cost less per inch of range than competitive tools."

**Try Hite-Set,** and you'll never settle for less! Ask your B&S distributor to show you this tool and the complete line of B&S inspection and gaging equipment. Brown & Sharpe Mfg. Company, Industrial Products Division, Providence 1, Rhode Island.

**Brown & Sharpe** PRECISION CENTER

*Attend the*

# INSPECTIONEERING WORKSHOP

*During the*

# 15th annual CONVENTION AND EXHIBIT

## AMERICAN SOCIETY FOR QUALITY CONTROL

**Hotel Sheraton, Philadelphia, Pa.**

JUNE 5, 6, 7

### MONDAY

**Qualifying and Training of Inspectors**

PATRICK J. NELLIGAN, Thompson Ramo Wooldridge, Inc., Minerva, Ohio

**PANEL: Measuring Your Inspector's Productivity**

ALBERT A. GOODMAN, Yale and Towne Manufacturing Co., Philadelphia, Pa.

STANLEY S. HART, Esterbrook Pen Co., Camden, N.J.

DAVID K. SNODGRASS, Leeds and Northrup Co., Philadelphia, Pa.

**PANEL: Cost of Inspection**

ROMAN E. BORUTA, Chrysler Corp., Trenton, Mich.

ROBERT G. MITCHELL, Wool-O Co., Philadelphia, Pa.

STANLEY B. SHERWOOD, General Motors Corp., Warren, Mich.

**Effective Organization of the Inspection Department**

EVERETT DALE, Minneapolis-Honeywell Regulator, Minneapolis, Minn.

**PANEL: Inspection Trouble Shooting**

CARL D. LARSON, General Tire and Rubber Co., Logansport, Ind.

NORMAL MILLER, Frankford Arsenal, Philadelphia, Pa.

RALPH E. WAREHAM, Management Consultant, Chappaqua, N.Y.

### TUESDAY

**Visual Inspection**

EDWARD R. CLOSE, Bausch and Lomb, Rochester, N.Y.

**Future Outlook for Inspection**

DORIAN SHAININ, Rath and Strong, Boston, Mass.

**Dial Gage Maintenance and Repair**

DOUGLAS CUNNINGHAM, Standard Gage Co., Inc., Poughkeepsie, N.Y.

**Simplifying Inspector's Reports**

FRANK CAPLAN, JR., Westinghouse Corp., Blairsville, Pa.

**Statistics Made Easy for Inspectors**

STANLEY WIRTSCHAFTER, American Machine and Metals, Inc., Sellersville, Pennsylvania

### WEDNESDAY

**What Inspectors Should Know About Sampling**

SEYMOUR V. LORBER, Department of Defense, Washington, D.C.

**PANEL: Limitations of Gages**

MICHAEL C. CURTIS, Timken Roller Bearing Co., Canton, Ohio

Col. W. J. DARMODY, Ret., Sheffield Corp., Dayton, Ohio

DAVID KIRK, Moore Products Co., Philadelphia, Pa.

**PANEL: Screw Thread Methodology**

MELVIN FREUTINICHT, U.S. Army Ordnance Gage Laboratory, Philadelphia, Pennsylvania

IRVING H. FULLMER, National Bureau of Standards, Washington, D.C.

F. MEYER, JR., Taft-Pierce Manufacturing Co., Woonsocket, R.I.

JOHN B. TWINING, Standard Pressed Steel, Jenkintown, Pa.

**Industrial Psychology in Relation to Product Quality**

Dr. RUSSELL E. LEITCH, Industrial Psychologist, Philadelphia, Pa.

**PANEL: Advanced Trends in Gaging**

ROBERT A. DANA, Hamilton Watch Co., Lancaster, Pa.

L. E. HENRYSON, Moore Products Co., Philadelphia, Pa.

DANIEL H. MOIR, Ford Motor Co., Dearborn, Mich.

WAYNE G. NORTON, Optical Gaging Products, Rochester, N.Y.

**It's QC in the Quaker City in 1961!**

*The following is a partial list of the displays you'll see at the Exhibit:*

American Cystoscope Makers, Inc.
Boonshaft & Fuchs
Brown & Sharpe Mfg. Co.
Convair
Diversa Electronics
Elliott Service Co.
General Electric, Specialty Control Department
Federal Products Corp.
Friden, Inc.
Hunter Associates Laboratory
The Martin Co.
Monroe Calculating Machine Co.
Moore Products
Rototest Laboratories, Inc.
Standard Gage
Testing Machines, Inc.
Thwing-Albert Instrument Co.

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***In the mails early in March***

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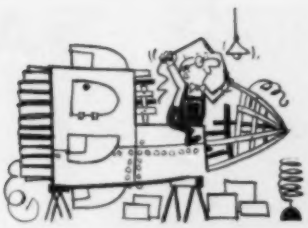
# PLANT TOURS



**Standard Pressed Steel Company**

**Manufacturers of fasteners that the Aircraft Industry swears by, not at. AOQL 0.14 percent on overall production, including government and commercial shipments. Should particularly interest metal and aircraft membership.**

**Military Clothing and Textile Supply Agency**

**A tour of the most complete and finest Textile Laboratories in the World. This visit will provide a rare opportunity for those members in the textile field.**

**Smith Kline and French Laboratories**

**These laboratories are equipped with the latest in automated and controlled equipment for the processing of pharmaceuticals to maintain the high quality so essential in this field.**

**Radio Corporation of America Moorestown**

**A must for those interested in electronics. Life testing of electronic components and the reliability of their application to such items as missiles, items that cannot be recovered for analysis.**

Quality control departments at each location will act as hosts and tour guides.

# Management's Corner

J. M. JURAN, *Editor*

# JAPAN REVISITED

Late in 1960, this department returned to Japan to lecture, this time on General Management of Industry. An earlier lecture series by this department,* in the summer of 1954, had been devoted to Quality Control. In the intervening six years the Japanese have wrought changes that must be seen to be believed.

The massive physical changes are, of course, the most obvious and dramatic. Great, gleaming multi-story buildings of steel and glass have been built and are a-building everywhere. Roads and bridges are wider and swifter. Bicycles have given way to motor cycles and automobiles. Little three-wheeled trucks have been replaced by modern monsters of the highway. And as in America, the road builders are losing the race to the vehicle builders.

Within the industrial buildings another revolution has taken place. Shops, mills and plants, as modern as anything on earth, are to be seen in many companies. The latest designs of foundries, textile machinery, transfer machines, assembly conveyors are there. New, authoritative instruments, bearing the ideographs "Made in Japan" regulate these processes.

The people behind these processes are no less impressive. Studious, inquisitive and energetic, they have learned to master these processes. Here and there they have gone further, and have seized process or product leadership. What has been only "here and there" may well, in the years ahead, become "often."

Attention to quality has become virtually a national movement. With the Surrender in 1945 there was swift realization that Japan must rebuild an industrial economy or be doomed to a continuing marginal level of existence; that for a large population on a small island territory this economy must be based on extensive export and import; that export and import must now be done by trade, not by conquest; and that to trade one must have quality products.

The industrial companies, their associations, their technical societies and their government all attacked this problem. They supplemented their knowledge by import. The American imports included Deming on Statistical Quality Control and this department on Management of Quality Control. They created independent inspection laboratories to certify goods for export.

An intense competitive stimulus was born a decade ago with the creation of the Deming prize. This prize, awarded by a committee of the Japanese Union of Scientists and Engineers, has become a recognized symbol of excellence in quality. The companies who receive it (there have been about two dozen in a decade) have earned for themselves an accolade reminiscent of the early days of the Army-Navy E.

Here again, it must be seen to be believed. Considering the use of the pictures of the Deming prize in product advertising literature, on television, on billboards, etc., it may well be that the benign visage of Dr. Deming has been viewed more often by the Japanese population than even that of General of the Army MacArthur.

The image is turned inward as well. When Nissan Motor Company received the prize, a miniature copy of the medal was struck and given to each of the 7000 employees. When this department (accompanied by OKUSAN) participated in the award ceremony for Kurake Spinning Co., we were in the middle of an event as memorable as the launching of a giant naval vessel.

Nor are the Japanese content to rely indefinitely on the foregoing. This department found itself participating in the first National Quality Month in Japan. An imposing array of Industrial, Professional and Governmental bodies were collaborating in a massive public relations movement. A special Q flag was flying everywhere. Special conferences on Quality Control were being conducted in 13 principal cities. Consumer reaction to quality was solicited within Japan, by the press, by the broadcasters, by advertising. Japanese quality performance was propagandized abroad.

With all this drive there is, of course, the inevitable resistance of a long-standing cultural pattern. Some of those gleaming buildings are erected with ancient types of bamboo scaffolding. One side of a factory aisle may exhibit an automated process which is nothing less than a masterpiece of engineering; across the aisle, operators are feeding machines one piece at a time in operations that fairly screams for simple magazine feeding methods.

Some of this cultural resistance is composed of things which we hope will never change—the profound appreciation of beauty, the stern concept of responsibility, the unfailing sense of hospitality. But the country is in the throes of a great fracture between two successive generations, and the new social direction is not easy to predict. But whatever may be the outcome of the great social enigma which faces this people, their achievement in Quality Control is probably unprecedented.

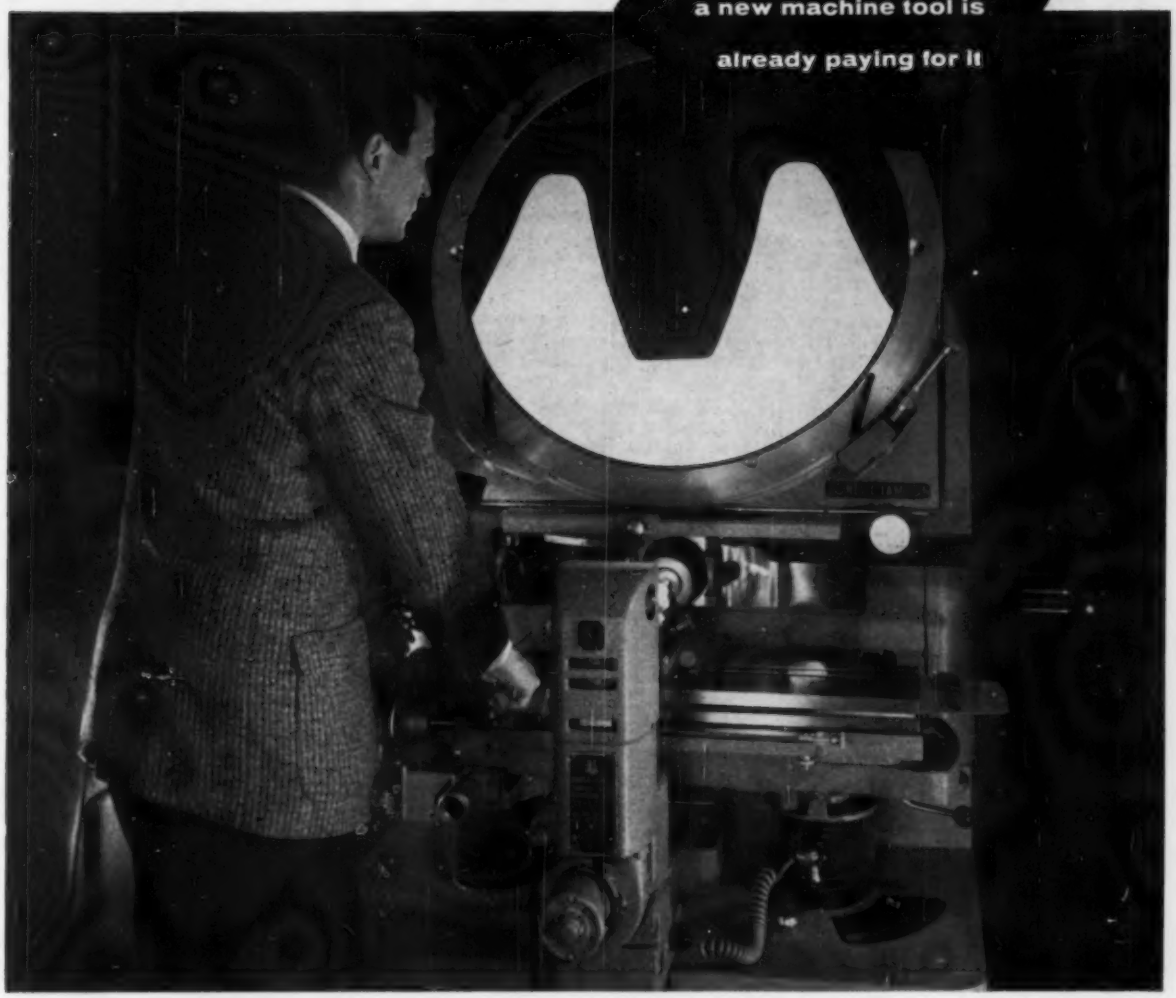
Prior to World War II, if one had taken an international public opinion poll on the product quality reputation of the various industrialized countries, the rankings would very likely have shown Switzerland at the top, followed by various other Western countries, and with Japan at the bottom. Now, two decades later, Japan has climbed that ranking, rung by rung, until it has arrived at a position of respect in most product categories, and to a position of leadership in some.

It is truly an outstanding achievement. To the outside observer it demonstrates what men of energy can do when they recognize a major problem and mobilize their resources to solve it.

*Be it understood that any overseas lecture trip invariably includes the unseen half of this department. In Japan she is referred to as OKUSAN (the honorable person of the inner house).

# JONES & LAMSON
# OPTICAL COMPARATORS

the man who needs
a new machine tool is
already paying for it



## This revolutionary new light source makes optical inspection more efficient than ever

Jones & Lamson now offers the J & L Mercury Arc Lamp, an entirely new light source unit that gives *more than 5 times the intensity of the best filament light source available today.*

This new unit, designed for use with any J & L 14-inch or 30-inch screen Comparator, actually gives a *new* kind of light . . . an extremely bright, *steady* arc, with *no* flickering. Its high intensity produces an incomparably bright screen with razor-sharp black shadow, even at highest magnifications.

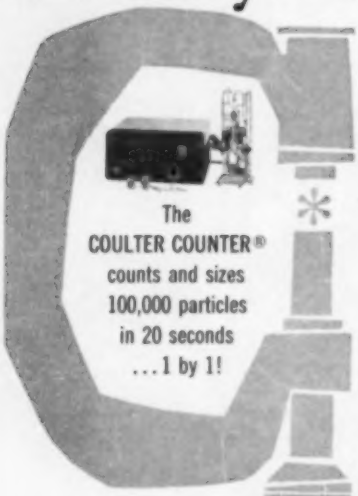
Thus, you can greatly increase the accuracy of your inspection and measuring with the J & L Comparator, even to the point of actually "splitting tenths". (For use at low magnifications, the light can be filtered readily.)

The J & L Mercury Arc Lamp comes as a complete, compact packaged unit, which plugs into any 110 volt outlet. It is quickly interchangeable with the standard light source of any Jones & Lamson 14-inch or 30-inch screen Comparator, and is a universal device which accomodates various standard makes of mercury arc lamps.

For detailed information and specifications, or a demonstration, contact your local J & L representative or write direct to Jones & Lamson Machine Company, 510 Clinton Street, Springfield, Vermont.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

# Break-through in fine particle analysis!




* *reproducible*
* *1500 installations*
* *range: .5 microns to 250 microns*
* *from catsup to ores; polymers to contaminants... whatever the material!*

Patented in U.S.A., Great Britain, France, Germany, Japan, Brazil and throughout the world.

Trade Mark

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☐ Please send complete details about the Coulter Counter.

☐ Have your representative get in touch for a demonstration in our office.

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## DoD Publishes H108, 110

Two new handbooks in the quality control and reliability series have been announced by the Office of the Assistant Secretary of Defense (Supply and Logistics).

They are DoD Handbook H108, "Sampling Procedures and Tables for Life and Reliability Testing (Based on Exponential Distribution)" and DoD Handbook H110, "Evaluation of Contractor Quality Control Systems."

H108 was developed to meet a growing need for the use of standard sampling plans for life and reliability testing when the exponential distribution of the times to failure is appropriate. These plans may be used to demonstrate the conformance of equipments, subassemblies and component parts to established quantitative reliability requirements.

H110 was developed to provide guidance to the Department of Defense quality control personnel in evaluating uniformly contractors' quality control systems as prescribed by MIL-Q-9858, "Quality Control System Requirements."

The Handbooks may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D.C. Prices: H-108—50 cents, H-110—40 cents.

## $2-Bill Payroll Puts Essex Industry on Playbill

To impress upon a community the importance of its industry, 18 industrial concerns in Essex, Conn., issued their entire weekly and semi-monthly payrolls in $2 bills.

One of the largest industrial concerns in the area, Cramer Controls Corp., had announced plans to consolidate all of its operations in a new million-dollar-plus plant, which would be built either in Essex or in nearby Old Saybrook.

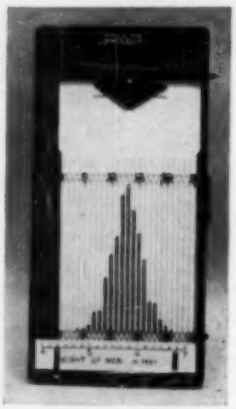
Local industry executives decided on the payment plan to impress on the community the value of its industry. Their firms inserted a full-page advertisement in the local newspaper, explaining the expected flood of $2 bills. Local banks cooperated by securing probably the largest supply of $2 bills ever issued at once. They kept more than 65,000 of the $2 bills, which were distributed to 1200 employees, in circulation for a week.

"Every time a citizen saw a $2 bill, he was aware that it had come from local industry," said Peter H. Comstock, program chairman. "It led many citizens to consider what Essex would be like without its industrial payrolls and how valuable more payrolls like them would be to the community. That's all we wanted to accomplish."


**USE A QUINCUNX . . . .**

to make your quality talk more forceful

to make your in-plant training course more effective



The Quincunx is a must for presentation of basic quality control principles. Demonstrates visually to your audience how a Normal Distribution pattern is formed. Also demonstrates how various Non-Normal distributions are formed.

**Lightning Calculator Co.**
Box 6192
St. Petersburg Beach 36, Fla.

**MEASUREMENTS TO 10 MILLIONTHS**

**. . . read directly on a counter!**

**CARSON-DICE AUTOMATIC Electronic Micrometer**

**Accurate!** The Carson-Dice Micrometer permits measurement to 10 millionths on any part or material, hard or soft, fragile or compressible.

**Foolproof!** Model P D R (shown) eliminates operator discrimination, measures with 0-pressure on conducting parts . . . or standard reference pressures of 1.5, 5, 10, and 20 grams on conductors or non-conductors.

**FAST!** Unexcelled for high-speed readings on close tolerance precision parts, semiconductors, deposited films, grids, coated cathodes, diaphragms, wire.

Address inquiries (and submit your measurement problems) to:

**J. W. DICE COMPANY**
**Englewood 10, N. J.**
**LOwell 9-0471**

# EX-CELL-O CONTOUR PROJECTORS GIVE YOU MORE—

1. **LARGEST WORK AREA**—Regardless of magnification there is a constant eight inches of work space from lens to focal plane to accommodate large objects. The Model 30 has a 12" diameter capacity.

2. **UNSURPASSED ACCURACY**—Kodak optics with famed Ektar® lenses guarantee accurate measurements and give clear undistorted images over entire screen. You can depend upon optical decisions made on the Ex-Cell-O.

3. **TRUEST MEASURING PRECISION**—All Ex-Cell-O Contour Projectors read to tenths and measure to tenths. Each Ex-Cell-O contour projector is tested and checked to the highest laboratory standards before shipping.

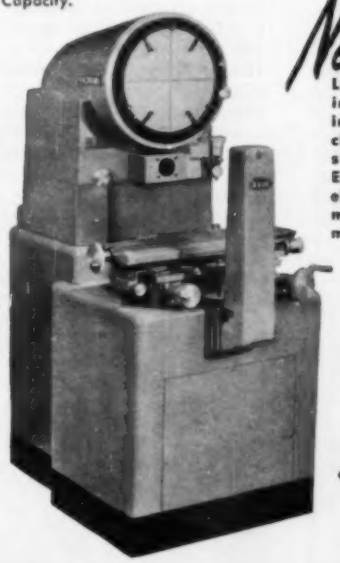
4. **BRIGHTEST GLARE FREE SCREEN**—Coated lenses and mirrors have been standard on all Ex-Cell-O models for many years. The patented "Fresnel" lens (exclusive with Ex-Cell-O) brings entire screen into clear view from normal operator position. Sharp clear images in normal room light—the brightest and clearest in the contour projector field!

5. **MOST RUGGED CONSTRUCTION**—Built to "stand the gaff." Solid construction with optical system locked into lifetime cabinets. Will withstand factory wear and tear—without getting out of adjustment. Guaranteed by Ex-Cell-O's long experience in the manufacture of precision machine tools.

6. **SIMPLEST OPERATION**—Finger tip controls, cool to the touch lamphouses, simple setting and measuring devices, unreversed images, all add up to comfortable day long operation. A precision machine of great accuracy that can be quickly mastered by average factory inspection personnel.

MODEL 30
A True, Heavy Duty Precision Measuring Projector with 30" Diameter Screen, and 12" Diameter Capacity.

*New!* **The Ex-Cell-O Mercury Arc Light Source Accessory. A high intensity Accessory light source including Mercury Arc Lamp, special collimator and auxiliary power supply. Quickly adaptable to all Ex-Cell-O Contour Projector Models (except Model 8) to give maximum screen brightness at higher magnifications.**



***Write for new booklet "See The Savings" which graphically demonstrates time savings through optical gaging over conventional methods.***

MODEL 14-5
The Finest, Most Versatile, 14" Screen Contour Projector Available.

**Manufactured by EX-CELL-O Corporation of Detroit, Mich.**

**SOLD AND SERVICED BY**

## OPTICAL GAGING PRODUCTS, INC.

**26 FORBES STREET ROCHESTER 11, N. Y.**

***(A subsidiary of EX-CELL-O Corporation)***

# What's New?

ROY A. WYLIE, *Editor*

**P-3-5**—Equipped with a newly developed caliper attachment, a Branson Sonoray ultrasonic flaw detector may be used to measure thickness of metals and plastics, from one side, to accuracies within ± 0.010 inch. The caliper consists of a fixed, scribed, vertical line and a second line on a slider, movable across the face of the cathode ray tube. A synchronized dial indicator measures the amount of this motion, permitting the operator to determine thickness directly, without calculations or interpolation. Although pulse-echo equipment, such as Sonoray, is principally used to ascertain the presence of hidden discontinuities, voids, slag inclusions, and severe porosity, the new accessory permits accurate location of these and similar flaws. Knowing how deeply these imperfections penetrate into sound metal often makes the difference between scrapping the entire component or salvaging it by machining off the damaged sections. The caliper attachment is available separately, for mounting on existing Sonoray detectors, or it may be ordered installed on the instrument. It weighs approximately one pound and is priced at $250.

* * *

**P-3-1**—A tiny micrometer that measures width dimensions has been announced by Navan. The new model permits direct measurements of internal groove and land widths in bores as small as a quarter of an inch in diameter. The instrument can be used to check work-pieces without the necessity of removing them from the machine. The "Mini-Mike" is a development under the patent application for the basic direct-measuring, internal-width micrometer, the "Multi-Mike."

* * *

**P-3-2**—Simmonds Precision Products, Inc., announces the design and development of a Flow Rate Comparator of laboratory accuracy. The instrument is designed to compare, calibrate and check accuracy of liquid flowmeters, including orifice, rotameter and turbine types. Designed to work with a range of liquid flow rates from 0-800 lb/hr, the basic unit requires an external electronic counter for a time-readout device. The flow rate comparator can be used without removing a flowmeter from its installation. The flow comparator operates on a dynamic weighing principle, electronically timing the flow of a known weight of liquid. Overall accuracy is ±0.25%; sensitivity is 0.0215%. The comparator is inertia compensated. The basic unit includes a balance scale, weights, weighing container, magnetic switch circuit (with cancelling switch), selector valve and plumbing. Operation of the flow rate comparator involves electronically measuring the time for fluid flow to balance a known added weight. A magnetic switch circuit senses start and stop of weighing cycle and triggers the electronic timer for this time period. Flow rate is computed from the indicated time, known added weight and a constant.

* * *

**P-3-6**—A new gear analyzer permits direct observation of shaft backlash angle due to an alternately applied clockwise and counter-clockwise torque and permits detection of minute shaft motion while determining breakaway torque. An amber light indicates when the desired backlash torque has been applied, and a red light indicates when the allowable breakaway torque has been exceeded. Both the backlash and breakaway torques are readily adjustable over a wide range of values. Various mounting adapters accommodate gear heads, servo systems, potentiometers, switches, valves, etc. The equipment employs dual purpose lever locks for restraint against shaft rotation and for positive zero position return to achieve measurement of shaft rotation within one minute of arc accuracy. A double collet sliding coupling transmits the backlash and breakaway torques which may be preset to any desired values within the selected instrument ranges, from 0.002 to 48 oz. in. Simple adjustment prior to testing assures full compensation for ambient conditions and internal aging effects. Solid State components provide maintenance free operation without external voltage regulation.

* * *

**P-3-4**—Physics Research Laboratories, American representative for C. P. Goerz, Otto Wolff and other distinguished European instrument firms, has opened its laboratory facilities on a commercial basis. Industry, particularly on the East Coast, now has available a standards, electrical testing and calibration facility, using standards and basic measuring instruments traceable to the National Bureau of Standards. This is accomplished by periodic submission of these standards and instruments to N.B.S. for verification and testing. The various methods used in the calibration facility are available to all in PRL's technical notes and published papers of the staff. These data are available on request, along with an illustrated brochure.

* * *

**P-3-8**—The range of digital voltmeters is extended to 1 microvolt DC with the new Kin Tel 459B/N floating, narrowband, differential DC preamplifier. Designed for general use, the unit provided stable, accurate amplification of low level input signals in the presence of high common mode noise and hum. Common mode rejection is 180 db for DC and 130 db for 60 cps with up to 1000 ohms unbalance in either signal lead. The input, which is completely isolated from both output and chassis ground, may be floated up to ± 250 volts with respect to ground. Small signals which normally would be masked by common mode hum and noise are isolated and amplified accurately. The Kin Tel 459B/N consists of two units: the 459B amplifier and the 459N module. The amplifier has fixed gains of −10, −30, −100, −300* and −1000* (*these settings are not to be used with tracking type voltmeters). A vernier control provides ±1% gain variation for system calibration and a zero control balances the amplifier and compensates for small DC offsets at the input. The module has input and output receptacles and a switch for connecting them together to by-pass the preamplifier. Input resistance is greater than 5 megohms. Price is $1475.

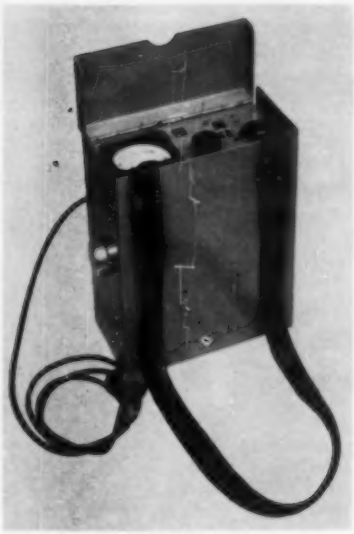
**Our Cover**

### *The Leprechaun*

Appropriate to the month of March and St. Patrick's Day is this month's cover picture of the "Leprechaun," an extremely flexible digital computer developed at Bell Telephone Laboratories for the Air Force.

Bell Engineers selected the name Leprechaun for this diminutive computer because in Irish folklore it literally refers to "the little people."

A good example of the impact that miniaturization is having on complex electronic systems, Leprechaun uses solid-state devices to reduce the awesome "giant brain" to comfortable file cabinet size.



**P-3-11**—The "Sortationer" will differentiate between various aluminum alloys and copper alloys by indicating the difference in conductivity of a layer near the surface. By special arrangement of the circuit, the sensing head has been made relatively insensitive to distance. It will give a virtually constant reading even if the head is not kept absolutely square on the surface or if the surface is uneven. It will also give constant readings whether the surface is anodized, painted or both. The Sortationer can be used to identify specified materials when they have lost their identity marks, to show degree of heat treatment, to distinguish in many instances between annealed and unannealed Alclad, to show heat damage to many treated alloys, to indicate which side of single sided aluminum coated shell is clad and to indicate the degree of heat treatment of a particular alloy, acting as a "go, no-go" gauge in heat treating processes. Also, it will differentiate pure aluminum and pure magnesium from all their alloys and will also differentiate between Tantalum and Niobium and between Gold and Silver and their alloys.

* * *

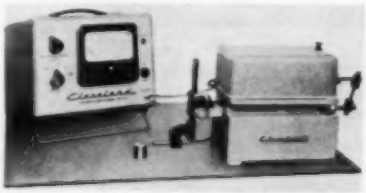
**P-3-7**—An electronic device, called the Detect-All Mark II, is designed for use as an accessory with the Fabrionics Warp Yarn Monitor, a photo-electric yarn defect detector. The unit detects and counts linear defects and end breaks and stops the warper for their removal. A feature of the system is the inclusion of a cathode ray oscilloscope. Detector signals are continuously monitored on the oscilloscope screen so the operator can identify and remove the sources of interference. The new system permits the Warp Yarn Monitor to be operated without a light cover so that yarn ends are readily accessible and rethreading broken ends becomes a simple matter.

**P-3-9**—The new Proficorder Internal Linear Pilotor is a major addition to the Micrometrical line of commercially available instruments for the measuring and recording of surface irregularities. The Linear, Rotary and Internal Linear Pilotors are interchangeable, having been designed for use with a common Amplicorder. The new Internal Linear Pilotor is an accessory which makes it possible to measure deep into out-of-the-way places. Round, square, rectangular and triangular shaped holes as well as many other odd shapes and sizes can be profiled with the Internal Linear Pilotor. Prior to the development of the new Pilotor, it frequently was necessary to cut parts in order to measure them. In the majority of cases, destructive testing is now a thing of the past, with resulting savings in time and materials.

* * *

**P-3-10**—As a result of two years' research, "blind" areas are now more closely viewable with the new, smaller diameter, "scanning-mirror" and adjustable focusing Inspectroscope which is for the first time available in the movable tip model ECM series. The "scanning" movement of the mirror from retrograde to prograde increases the field of vision 2½ times. Both the new mirror and movable tip are remote controlled by a fine gear mechanism, protected by a safety clutch. A clear view of material lying directly on the viewing mirror is made possible by a closer positioning of the mirror and light bulb. Magnification ranges from 10 power at the window to 1 power at a focal length of 2 inches. The reduction of the Inspectroscope's diameter from 11 to 9 mm allows freer movement in small openings. Custom built models range from 15 to 48 inches in length.

* * *



**P-3-12**—The Cleveland Instrument Company now offers three new skidless pickup models designed to measure very narrow or small areas, such as flanges, thread flanks, gear teeth, and small internal diameters, as well as "O" ring grooves. The Model BK 3922F Precision Slide makes possible surface measurements without skids—the reference line normally provided by the skids being generated by the slide. Movement of the slide is produced by mechanical coupling to Model BK 3911 Power Trace. With this combination, stroke adjustments are controlled from lengths of trace from 0.005 inches to 1½ inches. Surfaces of less than one microinch can

**New micrometer can measure internal lands and grooves to ± .0005" ...on the machine!**

Now, for the first time, you can measure internal lands and grooves, O-ring widths, retaining ring grooves, keyways, and cylinder grooves simply *and accurately*. The new Multi-Mike* internal groove micrometer operates just like any conventional micrometer. Easy-to-read Starrett micrometer head has graduations in thousandths of an inch. Multi-Mike can reach into, and measure, bores as deep as 5¾"; the two standard models fit holes down to ½" or ¼" diameters. The Multi-Mike measures groove widths from .050" to 1.050" and lands from 0 to 1.000". And this amazing new internal micrometer can do all this while the piece is still on the machine!

Multi-Mike produces higher quality work with lower cost set-ups and fewer rejections... gives you greatly reduced inspection and quality control costs. Write today for free literature.

*TRADEMARK; PATENT PENDING

*Multi-Mike Micrometer is another invention marketed by:*

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North American Aviation, Inc.
900/N North Sepulveda
El Segundo, California

easily be measured by the equipment mounted on the surface plate. Model MP 0002SL General Purpose Skidless Pickup is designed for the measurement of small I.D.'s and O.D.'s, flanges, thread flanks, gear teeth, or other applications where limited area measurements exist. With this equipment, measurements can be made to within 0.020 inches of the shoulder. It must be used with the Precision Slide Power Trace. For the measurement of surfaces behind flanges or shoulders and groove bottoms, the Model MP 6100 SL Groove Bottom Skidless Pickup is recommended. This model also must be used with the Precision Slide Power Trace. Existing Cleveland Roughness Meters can be used for skidless measurement with the addition of the Precision Slide, Model BK 3922R.

* * *

**P-3-3**—Tensile, compression and guided bend tests can all be made on a single new testing machine. Model TE-10-AS has a capacity of 10,000 pounds and is equipped with two gages to register the load applied in two ranges. Similar machines having other capacities can be provided. Motor and hydraulic power unit are located within the base of the tester, and the controls are conveniently mounted on the front. Guided bend testing, which consists of bending butt-welded samples that are originally flat into U-shapes at the welds, is performed in the compression testing area of the machine. The fixture, which conforms with AWS, ASME, ASTM, and U. S. Government specifications, consists of a punch secured to the underside of the upper platen and a die mounted on the middle platen by means of two locating pins. Fixtures are quickly interchangeable to permit testing butt-welded specimens of various thickness. When used as a tensile testing machine, a lower jaw holder is placed in one of the three sets of slots, to suit the specimen length. A variety of jaw inserts are available to hold specimens up to ½ inch thick by 1½ inches wide, or ¾ inch in diameter. The machine will accomodate specimens up to 8 inches long. Other models will handle longer specimens. When used for compression testing, the guided bend fixture is replaced by a pair of hardened compression plates. The space available for compression testing is 9½ inches high by 8 inches between the vertical pulling rods. This space will accommodate a Steel City dial indicator type proving ring for calibrating the machine.

6th ASQC Workshop - Seminar

# MANAGEMENT OF QUALITY CONTROL

April 6 - 7 - 8, 1961

Hotel Roosevelt, New York

**Sixth ASQC Workshop - Seminar**
**ASQC Institute**
**161 West Wisconsin Avenue**
**Milwaukee 3, Wisconsin**

Please make reservations for the sixth ASQC Workshop-Seminar on Management of Quality Control for the following man:

Enclosed is our check for $..... to cover..... registrants. Fee—$125 for non-members, $100 for members.

Name .....

Title .....

Company .....

Address .....

City.....Zone No. ....State.....

NOTE: Additional registrations may be made by attaching a list to this coupon. Please include necessary information for each registrant.

What is the purpose of the workshop seminar? To explore in depth, tested methods of increasing the effectiveness of the quality control program in an industrial plant.

For whom is the program planned? For present and prospective Quality Managers. It is expected that the applicant will have reasonable familiarity with such standard texts as Grant, Feigenbaum, and Juran. To benefit properly from the seminar, the applicant should have a minimum of several years experience with major responsibility for quality.

Registrants will be sent study materials and case studies prior to the conference. Registration is limited to 75 persons and is complete only on receipt of the registration fee of $125 for non-members, $100 for members, which includes the cost of three lunches.

Your Registration will be acknowledged. A room reservation card for the Hotel Roosevelt will be enclosed with the acknowledgment.

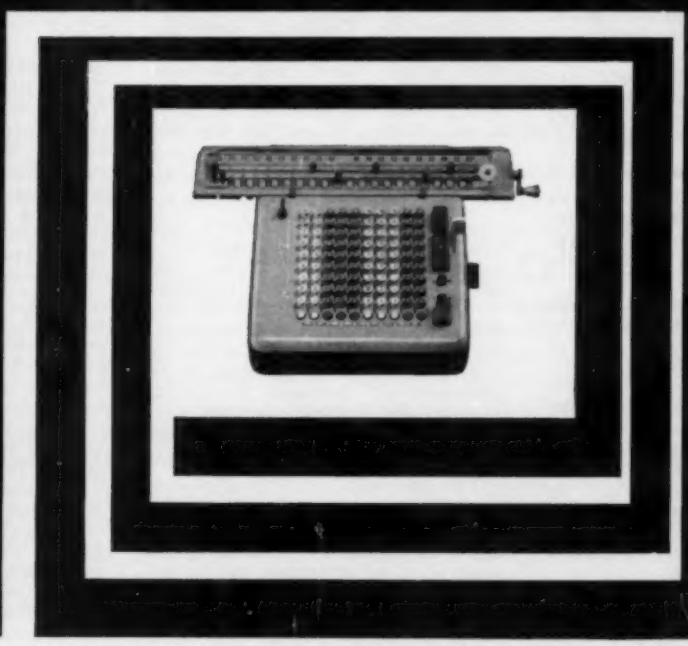
**ASQC Institute**
Paul C. Clifford, Director

NEW—*Another Achievement from Monroe*

Never before has so much calculator function been compacted into so small a unit. Or so low a price. This is LA-9, the newest, the ultimate in Monroe's famous L line calculators. This one's honored antecedents today are accomplishing their time and money saving missions on more desks in American business than any other calculator. LA-9 covers less area than a letterhead sheet, weighs less than 18 pounds. Yet this new compact automatically performs many of the jobs that much bigger and costlier machines do. Its peak performance is guaranteed and maintained by Monroe's nationwide service organization. And at so moderate a price, it can quickly pay for itself through its efficiencies.

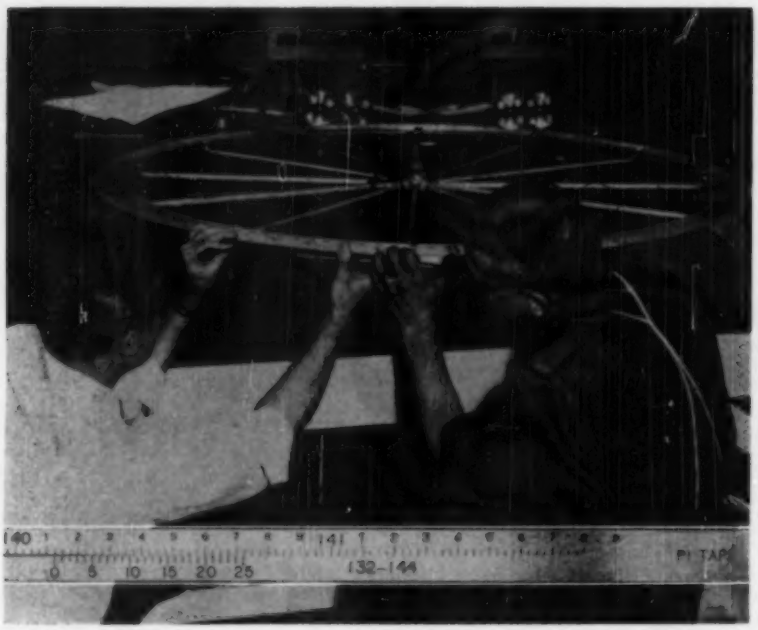
for CALCULATING · ADDING · ACCOUNTING · DATA PROCESSING MACHINES

See the MAN from MONROE



Monroe Calculating Machine Company, Inc. Sales and service in principal cities everywhere. General offices, Orange, N. J.

A DIVISION OF LITTON INDUSTRIES




**P-3-13**—A new vernier periphery or pi tape is a fast, most accurate method of measuring diameters of round or out-of-round parts. The circumference of the part is checked and the true diameter is read directly from the tape to an accuracy of 0.001 by means of special graduations and vernier. Only one measurement is necessary. Other methods require six or eight measurements and an average of these is taken. The tape can be used on items two inches or more in diameter. The tape can be used for either outside or inside diameter measurement. It is invaluable on sheet metal parts and practical on solid parts. Tapes can be furnished with GO and NO GO tolerance graduations. Tapes are made with the same precision as a micrometer and master checked to 0.001 accuracy. Fixed readings—no adjustments necessary.

### *Fifth District Conference*

The Third Annual Fifth District Conference sponsored by the Scranton-Wilkes Barre section, ASQC, will be held Mar. 25 at the YWCA, Scranton, Pa.

Luncheon Speaker will be Francis E. O'Gorman, University of Scranton, who will discuss the "Role of the Quality Control Worker."

Other topics include "Vendor Quality Control Procedure" by John Schneider, IBM; "Quality and the Production Worker" by John Sheldon, Bendix Corp.; "Subjective Aspects of Color Measurements" by Dr. S. M. Newhall, Eastman Kodak Co., and "Attainment of Reliable Product" by John Hershey, Bell Telephone Laboratories.

For additional information and registration, contact Eugene Krautter, QC manager, General Electric Co., P.O. Box 1068, Scranton, Pa.

### *New Literature Available*

**L-3-1**—A six-page, two-color folder describing their digital voltmeters is available from Non-Linear Systems, Inc. The folder points out exclusive features, such as snap-out readout, plug-in oil bath stepping switches, "no-needless-nines" logic, and 99% plug-in modular construction. The folder also has a section that illustrates each NLS instrument and gives brief specifications.

* * *

**L-3-2**—A new catalog that lists graph sheets and their special uses is offered by Keuffel & Esser Co. The 92 page booklet is illustrated with graph sheet reproductions, many of them in color. Descriptive text includes an introductory guide to the selection of grid patterns best suited to plotting business statistics, scientific data, sketching and drawing, surveying and mapping.

* * *

**L-3-3**—Bulletin GEA-7013 describes new electrical-physical measurements facilities available at the Schenectady Instrumentation Service Department, General Electric Co. The bulletin discusses solution of measurement problems involving complex and costly equipment, technical manpower and some typical and unusual measurement applications.

* * *

**L-3-4**—A guide to the selection and application of structural bolting for high-strength and elevated temperature applications is contained in a six-page editorial reprint offered by Standard Pressed Steel Co. Entitled "A Checklist on Fastener Reliability," the illustrated article pinpoints four key factors in fastener design, four in materials processing and seven in fabrication. Each is critical to the success of bolting in missile, aircraft, power generation and other high-stress mechanical applications.

* * *

**L-3-5**—A 16-page booklet, written in catalog style, gives a detailed presentation of the seven available Tektronix oscilloscopes with three-inch cathode-ray tubes, including the rack-mount models. The booklet contains complete specifications, performance characteristics, pertinent illustrations for all seven instruments.

* * *

**L-3-6**—Gaertner Scientific Corporation has published a new bulletin containing complete descriptive and technical data on its line of tape chronographs, drum chronographs and precision regulator clocks. Gaertner chronographs are instruments of high accuracy for recording time intervals.

* * *

**L-3-7**—A bulletin describing and illustrating 12 types of inspection lights has been issued by Welch Allyn, Inc. Included are direct types for surface or interior inspection, prefocused lights, adjustable focus lights, lights combined with magnifying lenses, lights with rotatable mirrors for right angle vision in relatively large bores, and borescopes for right angle vision in small bores.

* * *

**L-3-8**—Science Projects Handbook, edited by Shirley Moore, Science Clubs of America, published jointly by Science Service, Washington, D. C., and Ballantine Books, New York, N.Y., 254 pages, 50 cents (add five cents for packing for single copy orders). Today's best guide in the field of experimentation by youthful scientists. A young scientist can, with the help of this book, learn many vitally useful steps in the methods of getting started in science.

* * *

**L-3-9**—An attractive new, mirth-provoking *Laugh Book* has been published by Precision Equipment Co. Of interest to everyone, the *Laugh Book* is of particular value to those who must make an occasional public address or luncheon speech. Included are many cartoons by famous artists—cartoons such as Mr. Breger, Mr. Hubert, Cuties, the Girls and Strictly Richter. Also printed in this booklet are Precision's famous "Heard in the Locker Room" jokes. To obtain your free *Laugh Book*, request L-3-9, Product Education Service, inside back cover of this issue.

**Said Isaac Newton:**

*"Every particle of matter attracts every other particle with a force directly proportional to the product of their masses and inversely proportional to the square of the distances between them."*

Until recently, the thrust which propelled rocket vehicles into their coast stage, prior to orbiting, was provided by booster stages. The fuel carried by the satellite stage was used only to inject itself into orbit.

Now, however, a scientist at Lockheed Missiles and Space Division has evolved a Dual Burning Propulsion System which allows higher orbits and heavier payloads. With this system, the satellite vehicle fires immediately after the last booster stage burns out, thus augmenting the begin-coast speed. Later the satellite stage is re-started to provide orbit injection.

An even more recent development by Lockheed is a triple-burning satellite stage. This will permit a precise 24-hour equatorial orbit, even though the vehicle is launched a considerable distance from the equator.

These principles have made possible the early development of the MIDAS satellite. Moreover, they substantially increase the altitude and payload of the DISCOVERER series. Lockheed, Systems Manager for these programs and for the POLARIS FBM, is pursuing even more advanced research and development projects. As a result, there are ever-widening opportunities for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-15F, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

**Lockheed / MISSILES AND SPACE DIVISION**

*Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs*

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

**Pictured at the ASQC Electronics Division luncheon during the Seventh National Symposium on Quality Control and Reliability Jan. 9-11, Bellevue-Stratford Hotel, Philadelphia, Pa., were Henry Schumer, Paul Olmstead, I. W. Schoeninger, J. Y. McClure, Gordon Beckhart, Brig. General C. S. Hays (USA Signal Supply Agency), A. B. Mundel, and Stanley S. Hart. Seventy persons attended the luncheon on Jan 9.**

# section briefs

**AKRON-CANTON . . .** Mar. 16, "Non-Destructive Testing" by Bernard J. Cunningham, senior reliability engineer, Minneapolis-Honeywell Ordnance Division . . . Speaker has had wide experience in the supervision of all forms of non-destructive, destructive, and environmental testing — previously at the Westinghouse Atomic Fuel Depot and earlier as chief inspector of the Marion, Ind., plant of Anaconda Co.

December meeting, "Reliability Concepts as Applied to Military and Commercial Products" by Dr. G. Ronald Herd, research director of reliability and statistics, Booz-Allen Applied Research, Inc. . . . Considerable interest in reliability evidenced by the large attendance of members and guests. . .

*H. P. Pierce*

**ALBANY . . .** Mar. 2, officially declared as Ladies' Night . . . Following a cocktail party, 5:30 p.m., Crossroads Restaurant, Lathams, N.Y., Nick Demos, General Electric Co., Schenectady, N.Y., will present "Control Charts for the Factory can be Used in the Home" . . . This intriguing topic in the hands of the very capable and humorous Nick Demos should provide one of the outstanding programs of the season. . .

Apr. 2, Military Night, Hot Shoppe Restaurant . . . Early session by J. A. Trowbridge, General Electric Co., Pittsfield, Mass., on "Quality Control in the Ordnance Dept." . . . After dinner speaker — Richard P. Hussey, Office of Production Policy, Washington, D.C., with "What About MIL-Q-9858" . . . Should be interesting and informative — we're giving early notice of this important meeting so members will be able to invite interested guests. . .

*M. P. Flanagan*

**ALBUQUERQUE . . .** Mar. 10, All Day Conference "The Breakthrough to Higher Levels of Performance" at the Western Skies Hotel, Albuquerque, N.M., jointly sponsored by the section and the Albuquerque section of the American Institute of Industrial Engineers . . . Featured speakers are Dr. J. M. Juran, New York City, and Dr. W. G. Ireson, Stanford, Calif. . . . A special invitation is extended to those who would like to attend — cost per delegate will be $20.

*A. E. Clamp*

**ALLENTOWN-BETHLEHEM . . .** Dec. 14, Hotel Traylor, Allentown, Pa., 40 members and guests enjoyed our second buzz session on "Quality Control in Incoming Inspection" . . . Keynote speaker LeRoy Duncan, Reading Tool Corp., a senior member of our Reading subsection, set the stage with a short talk on "Incoming Inspection" . . .

That he did his job well was clearly in evidence at the six round-table discussions! Each of the tables was moderated by management representatives of the production branches of either the Dixie Cup Co., Easton; Atlas Powder Co., Tamaqua; Parish Pressed Steel Company and Carpenter Steel Co., Reading, or General Electric Company and Mack Trucks, Inc., Allentown.

After some 45 minutes of discussion at the tables, the moderators met with Mr. Duncan to review the views of the men at their respective tables and Mr. Duncan in turn relayed these views to the entire assemblage.

Certificates of completion were awarded to 14 members from Allentown and 16 members from Reading who recently completed our course — "Introduction to Quality Control."

*David F. Roberts*

**BALTIMORE . . .** Dec. 20, two papers by section members on plant applications of basic and new QC techniques . . . The presentations, for their uniqueness and down-to-earth applications, were enthusiastically received . . .

George Hurwitz, Quality Assurance Technical Agency, U.S. Army Chemical Center, Md., demonstrated the use of control charts by graphically showing the effects of test equipment in measuring test samples.

John F. Hird, planning engineer, QC engineering department, Western Electric Corp., discussed his experiences in applying basic statistical techniques to the

harvesting and transportation of bananas in Honduras. He was employed by the Standard Fruit & Steamship Co., New Orleans, La. In closing, Mr. Hird stated several sound rules to follow in improving the development of QC procedures — observe the difficulty first hand, form theories as to the cause, collect data, make objective analysis, accept or reject theories.

*A. M. Reek*

**BATTLECREEK-KALAMAZOO** . . . Dec. 15, joint dinner meeting with Lansing NAA at American Legion Club, Battle Creek . . . Well attended despite the fact that old man winter gave us some slick highways . . . Speakers — Russel Brown, director of budget control, and Mr. Christensen, QC director, both from Dana Corp. . . . Explained the close relations that exist between the cost and QC departments . . .

Mar. 16, dinner meeting, Inman's Inn, Galesburg, Mich., "The Selection of and Training of Inspection Personnel" by Milton Stratton, QC director, AC Spark Plug, Division of General Motors Corp., Milwaukee, Wis. . . . Mr. Stratton has attended the General Motors Institute, the University of Michigan, and the Milwaukee School of Engineering . . .

*Peter F. Koets*

**BOSTON** . . . Dec. 1, 55 attended the all day session on "The Practical Application of the Latest QC Tools for the Process Industries" . . .

Dec. 8, Frank Caplan, Jr., Westinghouse Corp., discussed "Production Line Experimentation" . . . Pre-meeting session "Statistical Techniques for a Chemical Process Laboratory" by William Grady, Carter's Ink, sponsored by the ASQC Chemical Division . . .

Dec. 1, Merrimac Valley Subsection "Malfunction Reporting" by Richard M. Jacobs, Sylvania Electric Co. . . .

Feb. 28, "Thinking Tools for Engineers," a ten meeting course, will be offered by our education committee, Bob Fabian, chairman . . . To be followed in March by an all day session on "Latest QC Developments" . . .

The Host Committee for the New England Conference to be held in Boston during October, 1962, is being formed with Shant Chebookjian, Polaroid, as general chairman . . .

*H. L. Keefe*

**BUFFALO-NIAGARA FALLS** . . . Nov. 28, at a well-attended meeting, the "Reliability Concept and Techniques of Application" was presented by Claude V. Hawk, director of reliability, Harrison Radiator Division, at the Park Hotel, Lockport, N.Y. . . .

Guests from the Harrison Radiator Division of General Motors included Fredric Ryan, chief engineer, and Bernard Howe, manager of inspection and quality control . . .

Mar. 27, Ladies' Night, plant tour of the Products Division, General Electric Co., Buffalo, N.Y. . . . Meeting to include nomination of officers . . .

*Dr. Irving Gordon*

**CHICAGO** . . . Mar. 8, Furniture Club of America, 666 North Lake Shore Drive, "Advance Methods in Statistical QC" by J. Stuart Hunter, University of Wisconsin, Madison, Wis. . . . Technical chairman conducting this program will be James Kennedy, Illinois Bell Telephone Co. . . . Pre-dinner social hour at 6 p.m. (or earlier) . . . Advance dinner reservations, $3.95, may be made by calling Miss Ann Livingstone, Zenith Radio, BE 7-7500, Ext. 425 . . .

We are now at the mid-point of the 1960-61 season. If you have not been able to attend your first meeting as yet, start being an active member by making that dinner reservation for the Mar. 8 meeting . . .

Thanks from all to Gilbert Sorbor, Western Electric Co., for the basic QC course he conducted at the University of Illinois, Navy Pier — attendance, interest at their peaks. Many thanks to Miss Mae Goodwin Tarver, Continental Can Co., for her wonderful assistance throughout the course.

*John Dittrich*

**CLEVELAND** . . . Dec. 2, the annual Ladies' Night and Social Night proved to be as successful this year as in the past. Miss Marvis Carroll, General Foods Corp., Tarrytown, N.Y., made her talk "Factorials Are Good to Eat" both interesting and understandable to both the members and their wives. A cocktail hour preceded the dinner, and an informal social hour was held after the meeting.

Dr. J. N. Berrettoni, chairman of the education committee, has announced two spring educational courses to be held this spring in conjunction with Western Reserve University. These jointly sponsored courses will be on industrial sampling plans and fundamentals of correlation. Details including fees and starting time can be obtained from Dr. Berrettoni.

*Howard O. Schmidt*

**COLUMBUS** . . . Dec. 15, the joint meeting with the Columbus chapter of AIIE was a great success . . . After a very good dinner at the Ohio Union, Ohio State University, Ralph Nottingham, director of QC and inspection and assistant director of research and development for North Electric Co., and James Ralph, QC supervisor, North Electric Co., presented a very enlightening program on machine capabilities . . . Their methods — simple and direct — gave those in attendance some new ideas to apply in their own plants . . .

Mar. 15, 8 p.m., plant tour of the world's largest manufacturer of automotive hardware, General Motors Corp., Ternstedt Division . . .

*G. E. Arris*

**CORNING-ELMIRA** . . . Dec. 13, Corning Country Club, DoALL Co., lecture and presentation "The Story of the Cutting Edge," attended by 80 members and guests — despite the stormy weather . . . C. G. Shelly, DoALL's representative, gave a very interesting talk on the historical development of cutting edges and their impact on our present and future society . . . Much interest was shown in the exhibits . . .

Mar. 14, 6:30 p.m., Hickory House, Horseheads, N.Y., Ladies' Night, "Design and Color Variation in Moderately Priced Homes," by Ogden McMahon, manager of National Homes . . .

*Richard J. Gibson*

**DAYTON** . . . December meeting, Brown Derby Restaurant, standing room only attendance for Christmas party and presentation by Alexander Sternberg, Missile and Space Vehicle Dept., General Electric Co., Philadelphia, Pa., on "Reliability from the Design Stage Through Mission Fullfillment" . . .

Mar. 5, Fifth Annual Dayton Conference, Biltmore Hotel, Dayton, Ohio — an outstanding event on this year's calendar . . .

Mar. 9, 8 p.m. Standard Register Co., "Small Lot and Short Run Quality Control" by M. F. Wilson, Collins Radio Co., Cedar Rapids, Iowa.

*Harleigh F. Diehl*

**EVANSVILLE-OWENSBORO** . . . Dec. 20, William E. Smith, QC manager, National Cash Register, Dayton, Ohio, flew into Evansville under adverse weather conditions for his talk on "Practical QC at National Cash Register Company" . . . He presented an excellent talk to less than ten members who braved the fiercest blizzard in years to hear him . . . The discussion session was especially informative due to the small number of participants . . . Our congratulations to the dedicated members who attended the meeting as well as to Mr. Smith . . .

Mar. 21, wives of section members are looking forward to a tour of Arkla Manufacturing Co. . . . Host for this tour will be Lou Fisher, the firm's QC manager . . .

*Wane E. VerWayne*

**GREATER DETROIT** . . . Dec. 19, 62 members toured the Hoover Ball & Bearing Co., Ann Arbor, Mich. . . .

They saw the complete statistical set-up by which the size of ball bearings is held to fine limits in the

Plans for a post convention conference in Mexico City as a continuation of the 1965 ASQC Convention and Exhibit in Los Angeles, Calif., were discussed Dec. 7 by Mexico City section members and ASQC Administrative Secretary William P. Youngclaus (second row, left, next to lighting fixture). The meeting was held in Mexico City at Hotel Vasco de Quiroga.

firm's new building. They also heard a talk by Dale Cue, QC director, on "Hoover Quality — A Way of Life."

Members of the staff showed processes and methods of sorting and gaging. Following coffee and doughnuts, a color movie clarified some processes which had been rather difficult to see as they were taking place.

A board meeting preceded the general meeting. It has been difficult to get reports of ASQC activities into the big city papers. Therefore, the discussion turned on methods for putting the entire membership to work on livelier and more imaginative public relations. Questions on memberships, meetings, and programs were discussed.

*Frances D. Huntington*

**HAMILTON** . . . Dec. 1, 70 members and guests were conducted on an extremely interesting tour of the research and development laboratories of Canadian Westinghouse Co. Ltd., Hamilton, Ont. . . . Work conducted in these laboratories falls into the categories of chemistry, metallurgy, mechanical engineering and electrical engineering . . . The greater part of the metallurgical work is directed towards nuclear reactor design and construction . . . We are grateful to Westinghouse management for their courtesy and hospitality . . .

Mar. 9, M. J. McKerrow, section engineer, Components and Standards Division, Canadian Westinghouse Co. Ltd., Hamilton, Ont., will speak on "Standardization and QC — Partners in Cost Reduction" . . .

*O. W. Holland*

**HAMILTON-MIDDLETOWN** . . . Mar. 1, 6:30 p.m., cocktail half-hour, 7 p.m. meeting in the Driftwood Room, Sports Bowl, Middletown . . .

Our speaker for the evening is Lt. Col. James R. Forrester. He has 21 years active duty with the Air Force, the last 15 of which have been spent with the Air Material Command which buys all aeronautical equipment for the Air Force. His present assignment is Chief of the Dayton Air Procurement District. His District is manned by 312 civilians and five officers who administer about 1200 AF contracts held by some 170 contractors in Ohio, Kentucky and Tennessee. Contracts total more than $500,000,000.

Quality control is an important area under his jurisdiction. From 1955-59 he was chief of the QC office at the Mobile Material area, Mobile, Ala. Here he was staff advisor to the Commander, Maj. Gen. D. F. Callahan. From 1952-55 he was Chief of the Propulsion Branch, QC Office Headquarters Air Material Command, Dayton, Ohio.

Colonel Forrester has been active in ASQC, having been a charter member and original organizer of the Pensacola-Mobile section. He served as 1958-59 vice chairman prior to his transfer to Dayton.

He has had specialized training in statistics and statistical QC methods at the University of Colorado and George Washington University. His formal education includes a Baccalaureate degree in Business Administration from Mississippi Southern College. He is also a graduate of the Air Force Command and Staff College.

Colonel Forrester's eight year's experience in the QC area while working directly with many Air Force contractors, plus his specialized training and education, give him an understanding of the interests of our own ASQC section and comprise qualifications for his talk to us on a QC subject from an Air Force management viewpoint—"Quality Control Relationships Between Contractors and the Air Force."

*Lon Ely*

**HARRISBURG** . . . Dec. 7, buzz session led by Richard Wise, AMP, Inc., Harrisburg, Pa. . . . Members were divided into six separate groups, each with a table discussion leader . . . Topics were "What Function Should a QC Department Perform?" and "What Part in These Functions Could be Relegated to Statisticians and Reliability Engineers?"

Mar. 1, 5:30 to 6:30 p.m., plant tour, Armstrong Cork Co., Closure Plant, Lancaster, Pa. . . . Dinner 7:30 p.m., Overlook Country Club . . . "Administrative Applications of Quality" by Carl E. Noble, manager of Marketing, Planning, and Research, Consumer Products Division, Kimberly Clark Corp., Neenah, Wis.

Apr. 5, Management Night, pre-meeting clinic 5:30 p.m., dinner 6:30 p.m., Castigilia's Restaurant, meeting 7:45 p.m., "A QC Program Should be a Cost Reduction Program," by Harmon S. Bayer, QC Consultant, Detroit, Mich. . . . The topic was of interest to management since Mr. Bayer has extensive experience in industry and teaching at the university level . . .

*Ann Englehart*

**HARTFORD** . . . Mar. 14, Nutmegger House, Newington, Conn., Leonard A. Seder, a QC Consultant, will speak on the "Control of Quality in Design" . . .

Dec. 13, Paul Shuttleworth's presentation was canceled due to a snow storm . . . However, the meeting has been rescheduled for Apr. 11 . . .

In the January, 1961, issue, IQC, it was stated that Allen Crawford was the January speaker — the speaker should have been listed as David W. Pertschuk. My apologies to both gentlemen . . .

*L. Sespaniak*

**KANKAKEE-JOLIET** . . . Dec. 6, members of this section who braved the first cold weather of the season enjoyed a very interesting tour of the Joliet Works of the American Steel and Wire Division . . . Guides conducted us through the extensive facilities of the plant, where many intricate processes were producing a wide variety of products . . .

Mar. 7, 7 p.m., plant tour, Simoniz Co., Kankakee, Ill.

Apr. 3, 6:30 p.m., Joliet, "Process and Quality for Management" by Walter T. Hayter, Youngstown Sheet and Tube Co. . . .

*John E. Rauworth*

**KANSAS CITY** . . . Dec. 15, R. D. Summers, Bendix Corp., gave an excellent dissertation on "Confidence Limits" . . .

Considerable interest was evidenced concerning the issuance of a monthly newsletter for our section. Former chairman Mike Putthoff has agreed to ramrod this and will get the project underway . . .

*H. Afton Taylor*

**LEXINGTON** . . . Dec. 15, Dr. A. W. Wortham, Texas Instruments, Inc., gave a most interesting discussion on "Relations and Inter-Relations in QC" . . . Dr. Wortham's presentation drew the section's largest turnout of the year and was very well received by a number of guests as well as members . . . His combination of mathematical formulae for cost calculations, with an informal discussion of common problems and projects involving the interrelationship of quality control with an organization's profit potential, made a valuable message to everyone present . . .

*J. Graff*

**LIMA** . . . Dec. 6, DoALL third traveling educational exhibit with C. G. Scheely, director of educational research, as the speaker . . . 90 members and guests viewed the presentation, which depicts man's million year record of the production and use of cutting edges — and the results attained . . .

The first exhibit, "Civilization Through Tools," portrayed the social and economic consequences of tool evolution. The second exhibit, "The Story of Measurement," portrayed, on panels and screen, a documented sequence of linear measurement standards and their use, from the first Egyptian cubit stick to measurement by light wave lengths . . .

Mar. 14, 7:30 p.m., Westinghouse Corp., "An Engineer's View of Tolerance," by Charles Miller, QC manager, Westinghouse Corp.

*E. K. Anderson*

**LOS ANGELES** . . . Dec. 14, Roy Marquardt, president, the Marquardt Corp., stressed a continuing requirement for improvement in communication from customer to contractor, from executive to operating management and throughout the total engineering and production structure, which would almost automatically eliminate a good deal of reliability problems . . .

"At Marquardt, we call our reliability program 'Intentional Quality,'" Mr. Marquardt said, "With our one intention being that of consistently meeting appropriate contractual requirements to furnish a reliable system."

D. L. Waters, vice president in charge of Marquardt's Power Systems Group, discussed the concept of "intentional quality" in relation to the research and development phases of the RJ43-MA-3 ramjet engine which powers the Bomarc missile.

Mar. 28, the Norair panel will be headed by R. S. Catlin, QC manager, Northrop Corp., Norair Division . . . E. C. "Bud" Bennett, chief, QC engineering, will be the spotlight speaker and will talk on "QC Relationship to Design" . . . R. R. Nolan, corporate vice president and general manager, Norair Division, will speak on "Top Management's Philosophy on Quality and Reliability" . . .

*Steve Kozich*

**LOUISVILLE** . . . Dec. 12, Jimmy Lewis Restaurant, 27 members and seven guests . . . Robert Fowler presented the educational capsule, followed by the guest speaker, A. Osse, with "Product Reliability" . . . Mr. Osse is an engineer with the Range Department, General Electric Co. . .

*C. R. Ferguson*

**MEMPHIS** . . . Dec. 13, the section was the guest of Plough, Inc. . . . The program featured a discussion on "QC Practices in the Flexographic Printing Ink Industry" . . . Moderator for the program was Don Henderson, national manager, Manufacturing Services, Dixie Wax Paper Co., Dallas, Texas . . . Speakers, all key technical personnel from Sinclair and Valentine Co., were Tony Cappucia, chief chemist, New York City; Rune Goop, chief chemist, California Branch, and Jaime Tobar, chief chemist, Mexico City branch . . . The program was very informative and well received . . .

Mar. 20, plant tour, Buckeye Cellulose Corp., with a panel discussion and refreshments . . . All members and guests are urged to attend . . .

*Lee Dickerson*

**MEXICO CITY** . . . Dec. 7, monthly meeting and dinner . . . We enjoyed having William P. Youngclaus, ASQC administrative secretary, as our guest of honor . . . Mr. Youngclaus gave us a talk concerning the contemplated post convention conference — in the City of Mexico — as a continuation of the 1965 Convention in Los Angeles, Calif. . . . The visit of Mr. Youngclaus developed a keen interest among our members . . .

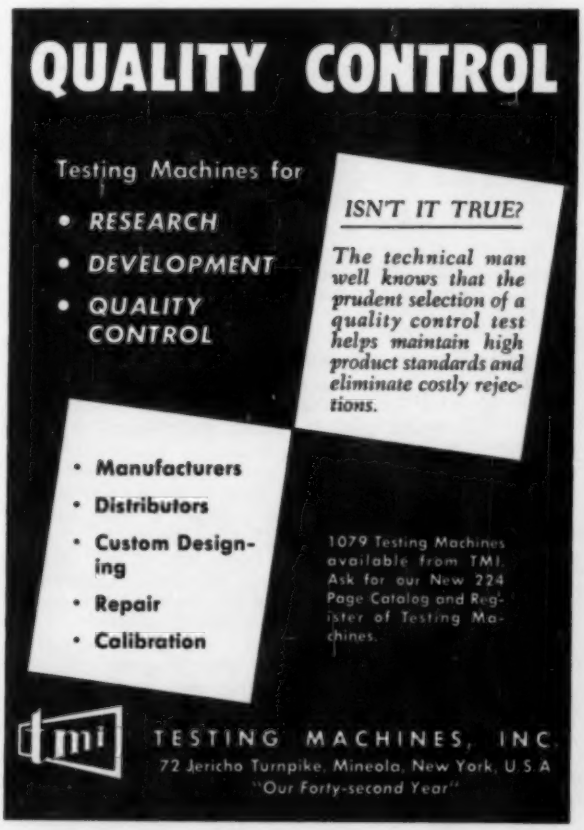
*Domingo M. López*

**MID-HUDSON** . . . Dec. 6, dinner meeting, Governor Clinton Hotel, Kingston, N.Y., the section was host to a joint meeting of the Technical Societies in this area . . . Guest speaker Jerome Barnum spoke on "How to Sell Your Ideas" . . .

Mr. Barnum, a dynamic international speaker, used many methods of gaining attention to the important points of his subject. He was an excellent "chalk" talker and held his audience of more than 200 persons in suspense throughout the evening.

All technical societies were exceptionally well represented. The Mid-Hudson section, ASQC, had one of the largest attendances with 43 members present . . .

*E. L. Leadbetter*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**MILWAUKEE** . . . Dec. 12, Ladies' Night, Milwaukee Inn . . . 65 ladies and gentlemen enjoyed the program of a top-notch comedy team of Billy Bishop An' Ann — the gentlemen particularly enjoyed watching the very pretty and appealing Ann . . . The act featured audience participation, a "rope tie," for which Billy won the Houdini award, and a trunk escape act . . .

The dinner and all the trimmings, which preceded the program, was served in a holiday atmosphere and was designed to put waist lines "out-of-control."

Mar. 17, all day Eighth Industrial Clinic sponsored by the Milwaukee ASQC section . . . Topics will include inspection and gaging, food and allied industries, general interest, and a top-notch series of training sessions . . .

*D. G. Schroeder*

**MINNESOTA** . . . Dec. 6, 65 members toured the Ford plant, St. Paul, Minn., and observed the functioning of remarkable production control on a continuous assembly line . . . The coordination of all departments results in the final assembly of not one type or color car but a great variety of styles and colors interspersed within the line . . . On the spot inspection assures the continuous flow of cars . . .

It is remarkable that a plant built in the days of one color, identical models is capable of a daily production of many models and colors almost equal to the original production of Model T Fords. It gives food for thought — is your production control, inspection and QC working up to maximum efficiency? It was a good tour and we hope to see more of the Ford people in our section.

*Violet M. Rice*

**MONTREAL** . . . Dec. 7, D. Arthurs of Sir George Williams University gave us a general outline of the application of semantics in everyday life and its role in industry . . . His topic — "Possible Solutions for Some Problems in Communication" . . .

From this lecture we think that the use of general semantics is a Quality Control procedure in the interpretation of events or messages with language symbols.

Mar. 8, A. B. Oxley, Canadair Ltd., will speak on "The Mechanics of Reliability" . . .

Mr. Oxley is the reliability co-ordinator at Canadair and is active in the reliability field with General Dynamics. Before working for Canadair, he was chief engineer with RCA Victor Ltd., Montreal.

Mr. Oxley is a Fellow, Institute of Radio Engineers, and a past chairman of the Montreal IRE section.

Mar. 22, section tour of the new $30,000,000 Trans-Canada Airlines Overhaul Base. W. L. Wingfield, TCA, vice chairman of the Montreal ASQC section, will act as host . . .

*T. F. Waterston*

**MUNCIE** . . . Mar. 16, John Waldner, Eli Lilly and Co., Indianapolis, Ind., with "Experimental Designs for Pharmaceutical Development" . . . Meeting at 6:30 p.m., Pine Shelf Room, Student Center, Ball State Teachers' College . . .

*C. B. Johnson*

**GREATER MUSKEGON** . . . Dec. 9, Wharf Bar Pavilion, 42 members and guests enjoyed a smorgasborg featuring ham, chicken, and 15 other dishes . . . Guest speaker — John Rutherford, Lear, Inc., with "Professionalism in Quality Control" — an excellent presentation of the history and future of quality control . . . Several pictures were taken for our scrap book . . .

Mar. 9, annual Shrimp Dinner and Social Mixer at the Mona Lake Yacht Club . . . This year the program will be recreation — card playing, pool, and just plain conversation . . .

*William A. Hume*

**NORTHEAST TENNESSEE** . . . Dec. 13, Student Center Bldg., East Tennessee State College, Johnson City, Tenn., with a pre-session clinic by W. F. Morgan, section chairman elect, who gave an interesting talk on

**Mrs. Charles R. Toye was presented a candy house during the Philadelphia section Christmas party Dec. 2. The house was constructed by Mrs. Harry Greiner. Mr. Toye is a member of the Lansdale, Pa., section. The gift was presented by a member of the Christmas party committee.**

"Reporting Quality Results to Management" . . . Mr. Morgan presented a system for making clean and concise reports to plant management . . .

Nicholas P. Demos, Data Systems Engineer, General Electric Co., Schenectady, N.Y., presented "Statistical Approach for Improving the Reliability of a Component" . . . The talk centered around the improvement of a component while still in the production stage . . . Attended and enjoyed by 36 members and guests . . .

*M. Gomez*

**ORANGE** . . . Dec. 15, Anaheim Bowl, Anaheim, Calif., program chairman Jack Miller introduced Ed Steinmeyer, Kwikset Locks; Howard Ingram, Northronics Systems Support, and Jack Miller, Beckman Instruments, who discussed "Quality Cost Reports" . . .

Preceding the regular meeting program, a very stimulating clinic session with moderator Howard Ingram and panelists Paul Rolfes, deputy chief, Inspection Division, U.S. Army Ordnance District, Los Angeles, Calif.; Ray Doty, chief, QC branch, Inspection Division, U.S. Army Ordnance District, Los Angeles, and Frank McNabb, QC director, Northronics Systems Support, Anaheim, Calif.

Future clinic sessions promise to be as stimulating and controversial as was this one — when representatives from the Navy and Air Force will be programmed to present their views and interpretation of MIL-Q-9858.

*Henry W. McKee*

**PARKERSBURG** . . . Dec. 14, this section heard a fine talk on "Atomic Radiation Uses in Quality Control" by C. B. Moore of the engineering department, E. I. Du Pont de Nemours & Co., Inc., Parkersburg, W. Va. . . . Mr. Moore's talk was very informative and thoroughly enjoyed by members and their guests . . .

Mar. 15, tour of Bureau of Public Debt . . . The Bureau's recently installed computers are expected to attract personnel from area industries . . .

*Robert R. Stewart*

**PENSACOLA-MOBILE** . . . Mar. 16, Dr. Edwin F. Moore with "The Role of Quality Control in Development" . . .

After holding faculty positions at four colleges and universities, Dr. Moore entered the field of Industrial Quality Control in 1954 with the Phillips Petroleum Co. At present, he is chief of the Quality Analysis Section, Solid Propulsion Operation, Rocketdyne Division, North American Aviation Corp.

Dr. Moore did his undergraduate work at Howard Payne College, Brownwood, Texas, where he received a B.A. in mathematics. He later received his M.A. in mathematics from the University of Texas and Ph.D. in statistics from the University of Missouri. Dr. Moore is a member of the ASQC Board of Directors, Midwest

QC Conference, and is chairman of the Waco section.

*Walter D. Nencka*

**PHILADELPHIA** . . . Dec. 2, Harry Greiner and his committee went all out to make the annual Christmas party a social success . . .

He promised quality as well as quantity and it was there in the food, music, gifts and atmosphere. All the ladies were awarded a gift by the chance method of drawing from a hat. The Grand Prize for the evening, a transistor radio donated by RCA, was given to the dance couple who was on the unknown "spot" when the music stopped for that particular number. The most unusual gift was a candy house which was beautifully decorated by Mrs. Greiner.

We were favored by many guests from other ASQC sections, including John Marck, chairman, and John Wargo, vice chairman of the growing Trenton section.

A November count shows total section membership to be 303. This includes 24 new members and is a good record. However, there are a few more renewals outstanding, so if you have not sent your check please do so at your first convenience.

*Albert G. Dettore*

**PITTSBURGH** . . . Dec. 13, joint meeting with the American Statistical Association . . .

It was most pleasurable to meet with members of the ASA and to discuss problem areas of mutual interest. The entire audience was then well rewarded for their time by a talk by Dr. R. Bradford Murphy, Bell Telephone Laboratories.

Dr. Murphy discussed several problems associated with life testing. He covered both the theoretical and practical viewpoints in his talk. He stressed that one of the more important problems concerns the selection of a particular life distribution.

Mar. 28, 7:30 p.m., the section wishes to extend an open invitation to members and guests who will be in our area to attend the plant tour of the Aliquippa Works, Jones & Laughlin Steel Corp. . . .

Steel making will be observed from raw materials to fabricated products. The control of quality in such a basic material and over such an integrated production operation will undoubtedly be one of the major highlights of our section's 1960-61 program.

*Chester R. Smith*

**PITTSFIELD** . . . Dec. 7, Dr. Harry G. Romig with "The Ethics of Professionalism Within ASQC" . . .

Dr. Romig is reliability director, Engineering Operations Research, Military Products Division, Hoffman Electronic Corp., Los Angeles, Calif. He is known nationally as a lecturer, teacher, and writer in the field of sampling, reliability, and quality control.

He accompanied his talk with slides and throughout the evening distributed papers to show us what is being done by other groups to further the work of QC and ASQC in this country and in foreign countries. He also told us about a typical Los Angeles ASQC meeting and the large number in attendance.

Following the meeting, pictures of Dr. Romig were taken with the executive committee.

*Howard J. Greenslet*

**PORTLAND** . . . Our March meeting will not be as originally scheduled due to the death of our principal speaker. Members will be advised of the new program by letter.

Herman Karlebach, section chairman; Henry Blood, education chairman, and Casey Hoekstra, membership chairman, will represent the section at the Western Regional Conference, Anaheim, Calif., Mar. 15-17. The executive board has given approval for the purchase of forty reams of paper to be used for publishing papers presented at the March conference.

May 13, Dr. J. M. Juran will conduct a one day workshop on "Quality Management" . . .

At the December meeting, Harold Hovland, vice president, Industrial X-Ray Engineers, gave a very interesting presentation on the use of X-Ray in non-destructive testing. Portland members of the NDT, along with members of the ASM, also attended. Everyone enjoyed the talk and the very colorful slides of X-Ray testing on natural gas pipe lines here in the Northwest.

*George Mickel*

**RHODE ISLAND** . . . Mar. 16, Engineering Society Bldg., Providence, R.I., "Management Bench Mark for Quality Control," by Edward M. Schrock, American Standard, Baltimore, Md. . . .

This program has been planned to stimulate thinking on what management expects from a quality control program, and to define the guide posts which may be used in measuring its effectiveness.

*Paul K. Moffat*

**RICHMOND** . . . Jan. 26, a basic QC course consisting of 10 two hour classroom sessions will be sponsored by the section and held at the Avco employment office classroom, each session beginning at 6:30 p.m. . . .

According to W. D. Smith, section chairman, the course will cover basic applications of statistical techniques as applied to inspection and quality control work. Topics to be discussed include basic probability theory, machine capability studies, control charting, and statistical sampling.

High school mathematics is the only prerequisite for the course which in the past has been given to more than 140 representatives of 19 industrial organizations in Richmond and surrounding cities. The course has been of interest not only to persons in inspection and quality control, but also those engaged in industrial engineering and laboratory work.

*Ralph Jester*

**ROCHESTER** . . . Mar. 28, 17th Annual QC Conference, University of Rochester . . . This event has always been well received by quality control people from Western New York, several of the nearby states,


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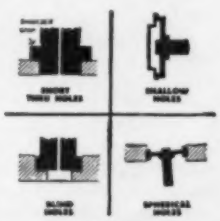

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and Canada . . . This year's program looks like it will once again be up to the high standards of the past . . .

Dec. 20, "The Big Picture" presented by Prof. Gayle W. McElrath and enjoyed by both ASQC and RSQC membership . . .

Each monthly meeting is a dinner meeting held in the Rochester Chamber of Commerce Bldg., 6:15 p.m., with the meeting starting at 7 p.m. It is not necessary to attend the dinner, but we find that most of the membership does attend it.

Apr. 10, the reliability subgroup will have as their speaker H. Yost, director of reliability, AC Spark Plug Division, GMC . . . Mr. Yost will speak on "Military Electronics Product Reliability at AC" . . .

*Al Rickmers*

**ROCKFORD** . . . Mar. 16, 7 p.m., Holiday Inn, "Inspection and QC of Screw Threads" by James L. Harris, QC manager, Standard Pressed Steel, Jenkintown, Pa.

Since the Rockford area is a large producer of screws and fasteners for the automotive and aircraft industries, the topic will be of special interest to our section. Several concerns in our area are well known throughout the country for their products and are ever aware of the requirements for better inspection and quality control procedures.

*Arvid R. Bloom*

**ST. CHARLES** . . . Dec. 20, Tally-Ho Restaurant, West Chicago, Ind., good attendance in spite of the cold snowy weather . . . "Integration of Quality Control" by Ted Krueger, Zenith Radio Corp. . . .

After his description and introduction of the QC program at Zenith, he showed a color film of his plant's quality program. Next he conducted a question and answer program in which he explained much more about the specific responsibilities of both the QC and the quality assurance groups at Zenith.

Mar. 21, Ivan D. Rinehart, General Electric Co., with "Communications" . . . Communications are one of the most important assets of any organization and Mr. Rinehart has prepared a very interesting program for us.

*Ellis Elder*

**ST. LOUIS** . . . Dec. 16, annual Christmas dinner-dance . . . 37 members and guests thoroughly enjoyed an evening of eating, talking, dancing and talking . . .

H. O. Hehner presented a paper entitled "How You Can Make a Multi-Plant QC Program Work" at the November meeting of the Northeast Tennessee section.

E. H. Barnett spoke on "Introduction to Evolutionary Operation" at the Boston section's one day Symposium on "Practical Tools for the Process Industries" on Dec. 1.

The 43 students from the Aero Chart and Info Center, USAF, who attended the section's special basic and intermediate courses in QC, were honored with a graduation dinner at Anheuser-Busch, Inc., on Dec. 7.

*W. W. Paris*

**ST. PETERSBURG-TAMPA** . . . Dec. 12. 45 members and guests traveled to the beautiful Schlitz Brewery in Tampa, Fla. . . .

Delmore Ehlers was the host and a most enlightening talk was given by Ron Roesler, a member of the QC department of the Tampa plant. A hospitality and social gathering followed the talk, with refreshments provided by Schlitz.

*H. L. Goldberg*

**SAN BERNARDINO** . . . Mar. 22, 7 p.m., Mural House, Ontario, Calif., "Product Support Group Responsibilities" by Russ Medlock, QC manager, Product Suppor Group, Convair . . .

*Gene A. Williams*

**SAN DIEGO** . . . Dec. 12, Sands Hotel, meeting enthusiastically attended by the third largest turnout in the history of the section . . .

The guest speaker, Charles Hirsch, Golden Nugget Casino, Las Vegas, Nev., very effectively held the attention of the entire house throughout the entire evening. I'm sure each of us in attendance now has an appreciation for the fact that gaming is big business in the State of Nevada and it makes good use of statistical applications. The theories of probability, control charts, and control chart techniques are used profusely.

Many of the problems associated with a Casino operation are not unlike the problems encountered in a manufacturing enterprise. This similarity can be visualized by the fact that several hundred pairs of dice are purchased every month with a receiving inspection rejection rate in excess of 40 percent.

Mar. 13, the entire San Diego section membership is looking forward to our second venture toward helping satisfy the curiousity of our juniors . . . It is hoped that this second "Juniors' Night" will be as successful as last year's endeavor. . .

*L. I. Frederickson*

**SAN FRANCISCO** . . . Dec. 12, panel meeting so successful that a similar type meeting will be held in May this year . . . At the December meeting, Jay Keate, Howard Heap, and John Ogden briefly discussed QC problems in can manufacturing, airline operation, and electric manufacturing industries . . . The question and answer period which followed gave all members an opportunity to discuss related problems in their fields.

*M. R. Hubbard*

**SEATTLE** . . . Mar. 14, 7:30 p.m., Benjamin Franklin Hotel, "Statistical Analysis," speaker to be announced.

*D. C. Lillis*

**SOUTH TEXAS** . . . The December social meeting was disappointing attendance-wise, but was certainly enjoyed tremendously by all who joined in the fun.

Due to the resignation of Jim Speer as co-chairman, Bob White was appointed to complete this season in that position. We are all sorry that Jim has found it necessary to take this step and we will miss him.

Mar. 22, 7:30 p.m., Ben Milam Hotel, "Non-Destructive Testing's Role in Quality Control," Dr. R. C. McMaster, Ohio State University . . .

*Ed Franklin*

**SOUTHERN CONNECTICUT** . . . Mar. 8, the Bryant Electric Co., Bridgeport, Conn., will be host to the section . . . Paul Bussette, director of purchasing, Burndy Engineering Co., Inc., Norwalk, Conn., will speak on "Purchasing and Quality" . . .

*Robert E. Kleid*

**SOUTHERN ILLINOIS** . . . Dec. 12, plant tour of Norge, Division of Borg-Warner Corp. . . .

At the meeting, a QC educational plan was explained by C. Kurtz. The plan entailed Southern Illinois University participation in an adult education QC class in the spring of 1961 and a formal course to be offered by the University in the fall term of 1961.

Mar. 16, C. W. Burgener, statistical department supervisor, Crab Orchard Plant, Universal Match Corp., with "Reliability and Its Applications" . . .

*C. O. Touchon, Sr.*

**SYRACUSE** . . . Dec. 13, A. P. Stergion, QC manager, Corning Glass Works, Corning, N.Y., with "Vendor-Consumer Relations" which stressed quality levels, acceptance sampling, and vendor certification from the vendor's point of view . .

Mar. 21, annual students' night at which we invite at least one student from each of the high schools in Onondaga County to be our guest for dinner . . . The topic of the program will be "Nuclear Energy Goes to Work" . . .

*Lee Huyler*

**TOLEDO** . . . Dec. 3, Christmas party with the wives a huge success . . . A fine buffet supper at the Engineering Societies of Toledo, followed by an evening of carol singing and dancing . . .

Mar. 2, EST, Dr. Brant Bonner, Dow Chemical Co., with "EVOP in Industry" . . . Our senior member,

Nelson G. Meagley, Continental Aviation, will be the moderator and will introduce the guest speaker . . .

Apr. 6, EST club rooms, Dr. E. B. Ferrell, director of communications techniques of research, Bell Telephone Laboratories, with "Reliability" . . .

*Carwin L. Elwick*

**TORONTO** . . . Mar. 11, Hart House, University of Toronto, Eighth Annual All Day Forum . . .

Mar. 22, Hamilton, Ont., plant tour, Dominion Glass Company, Ltd. . . .

*G. E. Culver*

**TUCSON** . . . Dec. 9, dinner meeting at the Tidelands Motor Hotel with a very interesting and entertaining talk by Herb Bjornburg, manager of purchasing, Air Research Corp., Phoenix, Arizona . . .

The topic — "A Common Effort" — pointed out the value of close coordination and cooperation between the purchasing and quality groups. Through the use of well prepared charts and good references, the impact of the subject was clearly felt. Included in the group were a number of USAF Quality Control representatives from Hughes Aircraft Co.

*Hughie W. Shea*

**UTICA** . . . Feb. 21, joint meeting with other engineering societies in recognition of National Engineers' Week . . . Dinner meeting at Twin Ponds . . . Speaker — James Bridges, director of defense research and engineering, Department of Defense, Washington, D.C. . . .

*D. Yeaton*

**WACO** . . . Plans were made at the December meeting to provide special sessions of discussion and lecture on basic QC and inspection concepts. These sessions are to be provided for new members who have not had an opportunity to learn these techniques.

The section also considered the instigation of a social hour prior to the dinner meeting in order to provide additional time for the exchange of ideas, fellowship, and to increase interest in meetings.

*Donald H. Barrett*

**WASHINGTON, D.C.** . . . Our fall training session at Georgetown University has been completed and all enrollees have successfully completed the requirements. A complete set of notes used in the course may be obtained for two dollars by contacting Alfred J. McKeon, section secretary, at the Bureau of Census. Topics covered by the notes and lectures are: "Introduction to Reliability Analysis," by Dr. G. Ronald Herd; "Introduction to Statistical Inference," by Dr. Howard L. Stier; "Analysis of Variance, I and II," by Dr. Chester H. McCall, Jr.; "Experimental Design," by Dr. William J. Youden; "Introduction to Operations Research," by Dr. Walter E. Cushen; "Techniques of Operations Research," by Saul I. Gass (I and II), Kenneth W. Webb (III), and "The Role of Statistical QC and Probability Sampling in Operations Research," by Dr. A. C. Rosander.

Mar. 15, 8 p.m., General Services Administration Auditorium, panel — Dr. Harold Bright, George Washington University; John Riordan, Department of Defense, and William MacCrehan, Bendix Aviation Corp., with "Training for Quality Control" . . .

*Eugene Tucker*

**WESTERN MASSACHUSETTS** . . . Mar. 14, 6:30 p.m., Sheraton Motel, Springfield, Mass., "Measurements and Quality Costs" by H. L. Freeman, QC Engineering Service, General Electric Co., New York City . . . Mr. Freeman will be introduced by Henry D. Johnson, newly elected president of the Strathmore Paper Co., who will act as host for the evening . . .

Dec. 13, a severe snow storm of the previous day prevented the attendance of the scheduled guest speaker, Ken S. Stephens, chief, QC Engineering Department, Western Electric Co., Inc., Allentown, Pa. . . . This was a disappointment for all of us . . .

However, the Chapman Valve Manufacturing Co., Indian Orchard, Mass., acting as host, did an admirable job in supplying speaking talent for the evening. David I. McIntosh, Jr., manager of manufacturing, gave a history of his company which included the period of inception and development of the QC department. Victor L. Bissonnette, QC manager, introduced William A. Schmidt, foundry metallurgist and engineer, who gave an extemporaneous talk. Mr. Schmidt, in borrowing the announced theme, "The Practical Application of Designed Experiments on Manufacturing Processes," from Mr. Stephens, our absent speaker, outlined actual designed experiments on manufacturing processes that proved very useful and helpful to the Chapman Valve Manufacturing Co.

We hope to hear Mr. Stephens at another date.

*Alan J. Donnelly*

**WICHITA** . . . Dec. 6, Jay R. Rumberger, general foreman, gage control, Kansas City Division, Bendix Corp., presented a very timely and interesting talk on "Gaging for Decision" . . . He summarized by stating that gaging for decisions to promote better controls can only be accomplished by a coordinated system that provides accurate fact finding through proper selection, correlation, maintenance and continuing improvement of the tools that supply the source of the information . . .

Mar. 7, our speaker, Paul Hill, has an excellent reputation for training QC and inspection personnel . . . He will speak on "Training of QC Supervisors and Inspectors" . . . Mr. Hill is with Fairchild Semi-Conductor Corp., Mountain View, Calif . . .

*Howard K. Mitchell*

**WINDSOR** . . . Bonjour, Monsieur — The annual Windsor section Christmas party was a success, due to the effort expended by Jim McMillan and Ross Goulin. The event was high-lighted by a buffet dinner at Mario's Restaurant and movies presented by Lorne Kowalsky. Jim McMillan led a vociferous sing-song. This was followed by the arrival of Santa Claus. The old gent carried two bags of tops and gifts for the children. A special vote of thanks was expressed to Mrs. McMillan for an excellent job with the gift purchasing and wrapping. Jim McBride extended his thanks and the season's greetings to the section members and their families.

*A. J. Hewitt*

## *Clair E. Zimmerman*

Clair E. Zimmerman, of 1528 Oakland Pkwy., chief inspector at Superior Tube Co., Wapakoneta, Ohio, died in his home Jan. 4, 1961, following an extended illness.

Mr. Zimmerman

Clair was born Jan. 31, 1916, in Tower City, Pa. He had lived in Lima ten years and was a member of Fort Amanda Lodge 706, Free and Accepted Masons; Market Street Presbyterian Church and the Elks Lodge. He was a member of the American Society for Testing Materials, served with the U. S. Marines in the South Pacific during World War II, and attended the University of Pennsylvania for two years.

He was a senior member of ASQC and a charter member of the Lima section. He was chairman of the section this year, after having previously served as program chairman and nominating chairman.

He was with Superior Tube Company for 25 years, rising through the ranks from inspector to chief inspector at the Wapakoneta plant.

# SECTION CALENDAR (MARCH 1 TO APRIL 10)

| SECTION | DATE | PLACE | TIME | SUBJECT | SPEAKER |
|---|---|---|---|---|---|
| Akron-Canton | Mar. 16 | Iacomini's | 8:00 p.m. | Non-Destructive Testing | Bernard J. Cunningham, Ordnance Division, Minneapolis-Honeywell |
| Albany | Mar. 2 | Crossroads Restaurant | 5:30 | Control Charts for the Factory Can be Used in the Home | Nick Demos, General Electric Co., Schenectady, New York |
| | Apr. 6 | Hot Shoppe Restaurant | 6:30 | What About MIL-Q-9858 | Richard P. Hussey, Office of Production Policy, Washington, D.C. |
| Albuquerque | Mar. 16 | Western Skies Hotel | 8:00 a.m. | All Day Conference — The Breakthrough to Higher Levels of Performance | Dr. W. G. Ireson, Stanford, Calif., and Dr. J. M. Juran, New York City |
| | Apr. 10 | To be announced | .... | Presentation of winning papers from competition sponsored by the section | Not applicable |
| Allentown-Bethlehem | Apr. 8 | Abraham Lincoln Hotel, Reading, Pa. | 8:00 p.m. | QC, the Seeing Eye of Production (Joint meeting with Reading Subsection) | R. G. Mitchell, International Latex Corp., Dover, Del. |
| Baltimore | Mar. 21 | Army Chemical Center, Md. | .... | Tour of Inspection Laboratories of the Army Chemical Corps Quality Assurance Technical Agency | Staff |
| Battle Creek-Kalamazoo | Mar. 16 | Inman's, Galesburg, Mich. | 7:00 | Selection and Training of Inspection Personnel | Milton Stratton, A.C. Spark Plug, Division of General Motors, Milwaukee, Wis. |
| Birmingham | Mar. 17 | Bankhead Hotel | 7:00 | To be announced | Chester T. Raymo, Steatite Division, American Lava Corp., Chattanooga, Tenn. |
| Boston | Mar. 9 | MIT Faculty Club | 8:00 | Recruiting, Training, and Professional Development of QC Administrators and Engineers | Panel discussion |
| | Apr. 13 | MIT Faculty Club | 8:00 | Interpreting Results from Testing Processes | Dr. Grant Wernimont, Eastman Kodak Co., Rochester, N.Y. |
| Merrimac Valley Subsection | Mar. 2 | Yankee Doodle Restaurant | 8:00 | Quality Training | Bernard Goldsmith, Northeastern University |
| | Apr. 6 | Yankee Doodle Restaurant | 8:00 | Controlling Quality | Leonard A. Seder, QC Consultant, Malden, Mass. |
| Buffalo | Mar. 27 | Products Division, General Electric Co., Buffalo, N.Y. | .... | Ladies' Night, Plant tour | Staff |
| Chicago | Mar. 8 | Furniture Club of America | 6:00 | Advance Methods in SQC | Stuart Hunter, University of Wisconsin, Madison, Wis. |
| Cleveland | Mar. 3 | Engineering & Scientific Bldg. | 7:45 | Professionalism and QC Engineers | Jack Rutherford, Lear, Inc., Grand Rapids, Mich. |
| Columbus | Mar. 15 | General Motors Corp. | 8:00 | Plant tour | None |
| Corning-Elmira | Mar. 14 | Hickory House, Horseheads, N.Y. | 6:30 | Ladies' Night, Design and Color Variation in Moderately Priced Homes | Ogden McMahon, Manager, National Homes |
| Dayton | Mar. 5 | Biltmore Hotel | 9:00 a.m. | Fifth Dayton QC Conference | Various |
| | Mar. 9 | Standard Register Co. | 8:00 p.m. | Small Lot and Short Run Quality Control | M. F. Wilson, Collins Radio Co., Cedar Rapids, Ia. |
| Greater Detroit | Mar. 21 | Arkla | 7:00 | Plant tour | Lou Fisher, Arkla |
| Evansville-Owensboro | Mar. 21 | To be announced | 8:00 | Professionalism — What's In It for You | James Barrabee, Hoover Ball & Bearing, Ann Arbor, Mich. |
| Hamilton, Ont. | Mar. 9 | Canadian Westinghouse Auditorium, Hamilton, Ont. | 8:00 | Standardization and QC — Partners in Cost Reduction | M. J. McKerrow, Canadian Westinghouse, Hamilton, Ont. |
| Hamilton-Middletown | Mar. 1 | Driftwood Room, Sports Bowl, Middletown, Ohio | 6:30 | QC Relationships Between Contractors and the Air Force | Lt. Col. James R. Forrester, Air Material Command, U.S. Air Force |
| Harrisburg | Mar. 1 | Closure Plant, Armstrong Cork Co., Lancaster, Pa. | 5:30 | Plant tour | Staff |
| | | Overlook Country Club | 7:30 | Administrative Applications of Quality | Carl E. Noble, Consumer Products Division, Kimberly Clark Corp., Neenah, Wis. |
| | Apr. 5 | Castigilia's | 5:30 | A QC Program Should be a Cost Reduction Program | Harmon S. Bayer, Consultant, Detroit, Mich. |
| Hartford | Mar. 14 | Nutmegger House, Newington, Conn. | 6:30 | Control of Quality in Design | Leonard A. Seder, QC Consultant, Malden, Mass. |
| Kankakee-Joliet | Mar. 7 | Simoniz Co., Kankakee, Ill. | 7:00 | Plant tour | Staff |
| | Apr. 3 | Joliet | 6:30 | Process and Quality for Management | Walter T. Hayter, Youngstown Sheet & Tube Co. |
| Kansas City, Mo. | Mar. 16 | To be announced | 8:00 | Organization and Administration of a Quality Program | W. L. Lieberman, Armour and Co., Chicago, Ill. |
| Lexington | Mar. 16 | Lexington Signal Depot | 7:00 | Rapid Analysis of Engineering Data | Dr. Lloyd S. Nelson, General Electric Co., Cleveland, Ohio |
| Lima | Mar. 14 | Westinghouse Corp. | 7:30 | An Engineer's View of Tolerance | Charles Miller, Westinghouse Corp., Pittsburgh, Pa. |
| Los Angeles | Mar. 28 | IAS Bldg. | 7:00 | Norair Panel | Norair Panel, R. S. Catlin, chairman |
| | | | | QC Relationship to Design | Spotlight speaker — E. C. Bennett |
| | | | | Top Management's Philosophy on Quality and Reliability | Guest speaker — R. R. Nolan |
| | Mar. 2 | IAS Bldg. | 7:00 | Inspection Division, Inspection for R & D Programs | J. Tamsen, Hughes Aircraft, and M. Collins, BMC |
| | Mar. 15 | IAS Bldg. | 7:00 | Measuring Missile Reliability | D. S. Stoller, Rand Corp. |
| Louisville | Mar. 13 | Hirsh Bros. Plant | 2:00 | Plant tour | Staff |
| | Apr. 10 | To be announced | 8:00 | Aligning the Product for Marketability and Flavor Response | Robert I. Tenney, Fleischman Malting Co., Chicago, Ill. |

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| Memphis | Mar. 20 | Buckeye Cellulose Corp. | 7:30 | Plant tour and panel discussion | John Smith and Jack Page |
| Mid-Hudson | Mar. 7 | Hotel DiPrima, Highland, N.Y. | 8:00 | Measurements and Quality Costs | H. L. Freeman, General Electric Co., New York City |
| Milwaukee | Mar. 17 | Milwaukee Inn | 9:00 a.m. | Eighth Industrial Clinic | Several |
| Minnesota | Mar. 15 | Holiday Inn | 7:30 p.m. | Zero Acceptance Sampling | Richard R. Carlson, McCullough Corp., Minneapolis, Minn. |
| | Apr. 11 | Holiday Inn | 7:30 | A QC Program Should be a Cost Reduction Program | Harmon Bayer, Industrial Consultant, Bayer, Kobert & Associates, Detroit, Mich. |
| Montreal | Mar. 8 | Ecole Polytechnique | 8:15 | Joint meeting with IRE, The Mechanics of Reliability | A. B. Oxley, Canadair Ltd. |
| | Mar. 22 | Trans-Canada Airlines | 6:30 | Plant tour | W. L. Wingfield, Trans-Canada Air Lines |
| Muncie | Mar. 16 | Student Center, Ball State Teachers' College | 6:30 | Experimental Designs for Pharmaceutical Development | John Waldner, Eli Lilly & Co., Indianapolis, Ind. |
| Greater Muskegon | Mar. 9 | Mona Lake Boat Club | 6:30 | Social mixer and shrimp dinner | Not Applicable |
| Northeast Tennessee | Mar. 14 | Kingsport, Tenn. | 6:00 | Cutting Costs with QC | J. Y. McClure, president, ASQC, with Convair, Fort Worth, Texas |
| | Mar. 16-17 | Student Center, University of Tennessee | 9:00 a.m. | QC Clinic, training program and general program of papers presented simultaneously | Richard Bingham, Carborundum Co., Niagara Falls, N.Y., and Irving S. Burr, Purdue University, Lafayette, Ind. |
| Omaha-Lincoln | Mar. 12 | Town and Country Motel, Lincoln, Nebr. | 6:30 p.m. | Mathematics in Statistical QC | John Birch |
| Parkersburg | Mar. 6 | Howard Johnson Restaurant | 6:00 | Election of Officers | Not applicable |
| | Apr. 1 | Howard Johnson Restaurant | 6:00 | Election of Officers | Not applicable |
| | Mar. 15 | Bureau of Public Debt. | 7:30 | Tour of Computer installation | Staff |
| Pensacola-Mobile | Mar. 16 | Holiday Inn, Pensacola, Fla. | 6:30 | The Role of QC in Development | Dr. Edwin F. Moore, Rocketdyne Division, North American Aviation |
| Philadelphia | Mar. 16 | Germantown Cricket Club | 6:15 | The Quality Demands of Space Technology | Arnold E. Hayes, vice president, Clifton Precision Products Co., Inc. |
| Pittsburgh | Mar. 28 | Jones & Laughlin Steel Corp., Aliquippa, Works | 7:30 | Plant tour | Staff |
| Pittsfield | Mar. 8 | Stanley Club, Pittsfield, Mass. | 1:00 | Joint meeting with IRE, AIEE | To be announced |
| Portland | Mar. 7 | Oregonian Hostess House | 7:30 | To be announced | To be announced |
| Rhode Island | Mar. 16 | Engineering Society Bldg., Providence, R.I. | 8:00 | Management Bench Mark for QC | Edward M. Schrock, American Standard, Baltimore, Md. |
| Rochester | Mar. 28 | University of Rochester | 9:00 a.m. | 17th Annual QC Conference | Several |
| | Apr. 4 | Chamber of Commerce | 6:30 p.m. | Weibull Sampling Plans | Henry P. Goode, Cornell University |
| Rockford | Mar. 16 | Holiday Inn | 7:00 | Screw Threads, Inspection and Quality Control | James L. Harris, Standard Pressed Steel, Jenkintown, Pa. |
| St. Charles | Mar. 21 | Tally-Ho Restaurant, West Chicago, Ind. | 6:30 | Communications | Ivan D. Rinehart, General Electric Co. |
| St. Louis | Mar. 17 | Golden Fried Chicken Loaf Restaurant | 8:00 | Accumulated Sum Control Charts | H. Mack Truax, Atlas Powder Co., Wilmington, Del. |
| St. Petersburg-Tampa | Mar. 13 | Morrison's Imperial House on Welsch Causeway | 6:30 | Film presentation and talk on the sciences employed in growing orchids and other exotic plants | R. Livingstone |
| San Bernardino | Mar. 22 | Mural House, Ontario, Calif. | 7:00 | Product Support Group Responsibilities | Russ Medlock, Product Support Group, Convair |
| San Diego | Mar. 13 | Sands Hotel, Clairmont Mesa Blvd., Highway 395 | 7:00 | Space Exploration and Space Medicine | J. Ryan, M.D., Space Medicine, Convair, Astronautics |
| San Francisco | Mar. 13 | Moore's Prime Rib Kart, Belmont, Calif. | 7:00 | Quality Assurance in a Complex System | Capt. B. L. Lubelsky, Los Altos, Calif. |
| Seattle | Mar. 14 | Benjamin Franklin Hotel | 7:30 | Statistical Analysis | To be announced |
| South Texas | Mar. 22 | Ben Milam Hotel | 7:30 | Non Destructive Testing's Role in Quality Control | Dr. R. C. McMaster, Ohio State University |
| Southern Connecticut | Mar. 8 | Bryant Electric Co., Bridgeport, Conn. | .... | Purchasing and Quality | Paul Bussette, Burndy Corp., Norwalk |
| Southern Illinois | Mar. 16 | To be announced | .... | Reliability | C. W. Burgener, Crab Orchard Plant, Universal Match Corp. |
| Syracuse | Mar. 21 | Tudors Restaurant | 6:30 | Nuclear Energy Goes to Work | J. L. Bernik, The Martin Co., Baltimore, Md. |
| Toledo | Mar. 2 | EST | 6:30 | EVOP in Industry | Dr. Brant Bonner, Dow Chemical Co. |
| | Apr. 6 | EST | 6:30 | Reliability | Dr. E. B. Ferrell, Bell Telephone Laboratories |
| Toronto | Mar. 11 | Hart House, University of Toronto | 9:00 a.m. | Eighth Annual All Day Forum | Several |
| | Mar. 22 | Dominion Glass Co., Ltd., Hamilton, Ont. | .... | Plant tour | Staff |
| Waco | Mar. 20 | To be announced | 7:00 p.m. | Demerit System for Evaluating QC Performance | S. D. Krasner, St. Louis Air Procurement District, St. Louis, Mo. |
| Washington, D.C. | Mar. 15 | General Services Administration Auditorium, F Street between 18th and 19th St., NW | 8:00 | Training for QC | Panel — Dr. Howard Bright, George Washington University, John Riordan, Department of Defense, and William MacCrehan, Bendix Aviation Corp. |
| Western Massachusetts | Mar. 14 | Sheraton Motel, Springfield, Mass. | 6:30 | Measurements and Quality Costs | H. L. Freeman, General Electric Co., New York City |
| Wichita | Mar. 7 | Continental Grill | 6:30 | Training of QC Supervisors | Paul Hill, Fairchild Semi-Conductor Corp., Mountain View, Calif. |
| Windsor | Mar. 21 | Veteran's Memorial Bldg., Detroit, Mich. | 8:00 | Professional development and panel discussion | James Barrabee, Hoover Ball and Bearing Co., Ann Arbor, Mich. |
| Worcester | Mar. 21 | Nick's Grille | 7:00 | QC and Industrial Engineering | Leroy H. Lindgren, Joy Manufacturing Co. |
| Youngstown | Mar. 2 | Astoria Cafe | 6:30 | Some Frustrations and Difficulties in Applying the Total QC Concept | Dale Cue, Hoover Ball and Bearing Co., Ann Arbor, Mich. |
| | Apr. 6 | Astoria Cafe | 6:30 | Design of Experiments | Dr. M. E. Terry, Bell Telephone Laboratories, Murray Hill, N.J. |

**WORCESTER** . . . Dec. 8, Worcester Polytechnic Institute, Ervin Taylor, Martin Co., Baltimore, Md., discussed the "Frequency Distribution Analysis Sheet" as used by his company to analyze process data . . . Mr. Taylor used slides to illustrate his talk and distributed work papers whereby all members graphically obtained the frequency distribution, percent beyond specifications, confidence limits of the average and sigma values, and control limits for average and range charts . . .

Mar. 21, Nick's Grille, joint meeting with the American Institute of Industrial Engineers . . . Leroy H. Lindgren, Joy Manufacturing Co., will speak on "Quality Control and Industrial Engineering" . . .

*Daniel J. Burda*

**YOUNGSTOWN** . . . Dec. 1, Astoria Cafe, Dr. Fred Kindig, associate professor of industry, University of Pittsburgh, with "Fundamentals of Linear Programming" . . . Dr. Kindig has had wide experience in industry and has written many manuals on quality control.

Dec. 15, Christmas party, King's Table Restaurant . . . A fellow member and engineer at Packard Electric, General Motors Co., William Lisby, provided acts of magic and ventriloquism . . .

Mar. 2, Dale Cue, quality manager, Hoover Seal and Bearing Co., Ann Arbor, Mich., with "Some Frustrations and Difficulties in Applying the Total Quality Control Concept" . . .

Apr. 6, Dr. M. E. Terry, member, technical staff, Bell Telephone Laboratories, Murray Hill, N.J. with "Design of Experiments" . . .

*Charles T. Wirebaugh*

## *Significant Differences*

. . . ALLENTOWN-BETHLEHEM — On Dec. 15, **Ken Stephens** and **Bob Schin,** Western Electric Co., attended a meeting of the program planning committee for the 1961 ASQC Convention and Exhibit in Philadelphia.

**Bob Ickes,** a charter member of our section, a longtime employee of Western Electric Co., has returned to the local scene after having spent several years at the Hawthorne Installation of Western Electric. He will be assistant superintendent of microwave tubes and metal piece parts manufacture at Allentown. Good to see you back again, Bob!

**Will Rothrock,** Western Electric Co., has been promoted from QC engineer to the engineering department of semiconductor development.

. . . BINGHAMTON — If you want something done give it to a busy man. In addition to his new assignments at Line Material, our chairman, **Don Brown,** has found time to write newsletters to the section and to recruit new members.

. . . BOSTON — **Francis Kilduff,** supervisor of QC, instrument development laboratory, Attleboro, Mass., to manager of QC and general services, same firm.

. . . CHICAGO — Due to a heavy workload, **Samuel Richards** has resigned as secretary of the Chicago section. Members of the section extend their thanks and wish Sam much luck in all his efforts. At the time of this report his successor had not been named.

. . . CLEVELAND — Congratulations are due vice chairman **Dr. Lloyd S. Nelson,** General Electric Co., on his appointment as district seven representative.

. . . DAYTON — **John E. Condon** has been appointed reliability manager, Military Development and Marketing Department, National Cash Register Co., Dayton, Ohio. He was formerly in the Advanced Projects Department of the Company.

. . . HARTFORD — **Ken Martin** has been promoted to quality manager of Veeder-Root, Inc.

. . . KANSAS CITY—Congratulations to **Fred Lorenz,** formerly senior QC analyst, to inspection process engineer, Bendix; **Warren T. Hornsby,** formerly QC staff assistant, to QC supervisor, Hallmark Cards; and **H. Afton Taylor,** formerly QC staff assistant, to QC supervisor, Hallmark Cards.

. . . LEXINGTON — Thirteen students completed a twelve week course in basic statistics which the Lexington section sponsored at the Lafayette Vocational school. **John Sisto,** associate mathematician with IBM, was the instructor. A class in intermediate QC is being sponsored and continues under John's leadership.

. . . LOS ANGELES — **William A. Chapin,** section vice chairman, has been appointed director of quality, Autonetics Division of NAA.

Col. **Frank Genetti,** director of procurement, and Col. **Marvin Goodwin,** staff judge advocate, San Bernardino Air Material Area, were honored guests at the December meeting of the Los Angeles section. **E. J. (Jack) Lancaster** expressed the section's appreciation for their fine interest in the field of quality control and reliability.

**Peter Schnipper,** formerly in QC management with Fairchild Controls and Triad Transformer Co., has been appointed QC manager with Perkin Electronics Corp., El Segundo, Calif.

. . . MID-HUDSON — On Sept. 10, **F. J. Sindelar,** QC manager, Poughkeepsie plant, IBM, chairman of the Constitution and By-Laws Committee, ASQC, and a member of the Mid-Hudson section executive committee, spoke at the All Day Conference at Rutgers • The State University. His topic was "Management Planning and Control for an Effective Quality Function." As a result of this speech, Mr. Sindelar has been requested to submit his paper for publication in *IQC*.

. . . MILWAUKEE—**David Atchley,** QC supervisor for Line Material and chairman of the section's professionalism committee, has transferred to the East Strandsburg, Pa., plant.

**Ed Harry,** formerly QC supervisor, has transferred to customer service at Bucyrus-Erie Co. Ed is Milwaukee section arrangements committee chairman.

Mrs. **Pat Mulgrew** has left Centralab Division, Globe Union, Inc., as QC engineer, to accept a position in Civil Service for Milwaukee County. Mrs. Mulgrew, a senior member, has served on various section committees.

**Donald Mittelstadt,** a section member, is now employed as a reliability engineer for Minneapolis-Honeywell Regulator Co.

. . . MINNESOTA—**Byron Brown,** program chairman and a faculty member of the Biostatistics section, School of Public Health, University of Minnesota, just completed teaching a ten week course via the University TV station entitled "Statistically Speaking." Bill's session just before the election must have made a few voters realize that facts, and figures, when improperly or inaccurately assembled, can be made to fit the candidate and his conclusions. All in all, the course should have given many a businessman, large and small, some idea of the value and use of statistics in business, both in his day to day business and his predictions as to the future. Nice going, Bill—hope you give a follow-up course next winter.

**George Osborne,** The Toni Co., St. Paul, Minn., was recently promoted from supervisor of Line Inspection to QC engineer.

. . . MONTREAL—**John Ferguson,** our member from Nova Scotia, has relocated in the Montreal area with Canadair Ltd.

. . . MUNCIE—**R. C. Hariff** has been named supervisor of QC at the new Westinghouse plant in Muncie. The new plant will make huge transformers for sub-stations which will require special flatcars for shipment.

. . . NORTHEAST TENNESSEE—Commander **Wilbur Y. Morton,** representative, Bureau of Naval Weapons, Bristol, Tenn., was a guest of the section at the December meeting.

**Billy W. Riggs,** section member, Raytheon Co., Bristol, Tenn., has been promoted to assistant foreman, inspection.

Two courses are being jointly sponsored by the section and the State and City School Boards in Kings-

port, Tenn. They are analysis of industrial experiments and intermediate industrial statistics.

March 16-17—Annual QC Clinic, University of Tennessee, sponsored by the Northeast Tennessee section, the Tennessee section, and the University of Tennessee. The clinic will be held at the Student Center and will consist of a training program and a general program of papers presented simultaneously. The opening speaker for the clinic will be **Richard Bingham,** Carborundum Co., Niagara Falls, N.Y. The luncheon speaker for the second day will be **Irving S. Burr,** Purdue University.

. . . ORANGE—**Jack Miller,** formerly quality assurance administrator, Beckman Instruments, Inc., Fullerton, Calif., is now corporate quality assurance administrator at Spinco Division, Palo Alto, Calif.

**John Pamparin** is now assistant to the president at Systron-Donner Corp., Concord, Calif.

. . . PENSACOLA-MOBILE—**Fred Seguin** has been promoted chief, quality audit section, supply QC division, Directorate of Supply and Transportation, Mobile Air Materiel Area.

**William A. Bivin** has been promoted from aeronautical and miscellaneous equipment inspector to mechanical equipment QC specialist in the staff QC office, Mobile Air Materiel Area.

Lt. **Walter Nencka** has been transferred from the quality engineering division to the quality management division of the staff QC office, Headquarters, Air Material Area.

. . . PHILADELPHIA—Vice chairman **Tom Moran** has been doing some fine QC counselling work with the other sections.

. . . PIEDMONT—Dr. **Dudley J. Cowden,** professor of economic statistics at the University of North Carolina, recently received leather-bound deluxe editions of two of his books at a luncheon in Durham, N.C.

The deluxe editions of *Applied General Statistics* and *Practical Business Statistics* were presented to Dr. Cowden on Dec. 6. Both books have attained sales of more than 100,000 copies.

*Applied General Statistics,* presently in its second edition, was first published in 1939. In addition to its publication in England by Pittman, the book has been published in Spanish and Portuguese language editions and in braille. Vinylite recordings are being made by Recording for the Blind, Inc.

*Practical Business Statistics,* which was originally published in 1935, is now in its third edition. It is currently being translated for Japanese language publication.

Dr. Cowden is also author of *Statistical Methods of Quality Control.* This book was published by Prentice-Hall, Inc., in 1957. Arrangements have been concluded with Japanese publishers for an English-language reprint and a Japanese language edition of the book.

. . . PITTSBURGH—**Charles W. Folsom** has been promoted to branch supervisor, Sharon Division, QC section, inspector of naval material, Pittsburgh, Pa. He will reside in Masury, Ohio, and will be a member of the Youngstown, Ohio, section.

. . . PORTLAND—One of the section's outstanding members is being transferred. **Bill Conrad** of Lucky Lager Brewing Co., has been promoted and transferred to Salt Lake City. Mr. Conrad was chairman during a most successful year.

. . . RICHMOND—**Norbert L. Enrick** has resigned as associate director and head of operations research of the Institute of Textile Technology to become associate professor at the Graduate School of Business Administration, University of Virginia at Charlottesville.

. . . ST. CHARLES—An intermediate QC course entitled "Analysis for Decision Making" is being taught by **Ray Swenson,** assistant professor of industrial engineering, Illinois Institute of Technology. Mr. Swenson is currently completing work for a Ph.D. degree at the University of Chicago.

. . . SAN BERNARDINO—**Gene A. Williams,** section reporter, is now with Aerojet-General Corp., Azusa, Calif., as a QC engineer.

. . . SAN DIEGO—**L. I. Medlock,** chief of support QC, Convair-Astronautics, has been named Convair operations manager of Atlas Missile Complex III at Warren AFB, Wyoming.

. . . SAN FRANCISCO—**Marion M. Sandomire,** having completed a term of office as secretary-treasurer of the Western North American Region of the (international) Biometric Society, has been elected a member of the Regional Advisory Committee.

**Alfred M. Garland** has been promoted to QC manager, Mare Island Naval Shipyard.

**Harry Conder, Bruno Filice, Stanley Hotchner, Norman Olson** and **Gordon Rowe** assisted in the instruction of a short course in QC for personnel in the food processing industry. The course was conducted at Oregon State College, Corvallis, early in December.

. . . SOUTH TEXAS—Due to the resignation of **Jim Speer** as co-chairman, **Bob White** was appointed to complete this season in that function. We are all sorry that Jim found it necessary to take this step and we will miss him.

. . . SOUTHERN CONNECTICUT—**Bob Kleid,** formerly with Sperry Rand Corp., is now with the jet engine department, General Electric Co., as supervisor of advanced quality control at their Everett, Mass., plant.

. . . SOUTHERN ILLINOIS—**R. W. Buchanan,** quality assurance manager, Crab Orchard plant, Universal Match Corp., has been promoted to quality assurance manager, Heavy Equipment Division, Ferguson Plant, Universal Match Corp.

. . . TUCSON—**Hugh Dodge,** formerly of Hughes Aircraft, Tucson, has joined the staff of the Satellite System Division, Lockheed Aircraft, Sunnyvale, Calif.

**Ella Scofield** has also moved from Hughes Aircraft Co., Tucson, to Sunnyvale, Calif., where she will continue in the field of statistical analysis in the Missile and Space Division of Lockheed Aircraft Corp.

. . . WASHINGTON, D. C.—Dr. **Howard Stier,** National Canners Association, has been appointed chairman of the new Food and Allied Industries Division, ASQC. Our thanks and gratitude go to lecturers and participants in our fall training session.

. . . WICHITA—**Jay R. Rumberger,** our December speaker, is a close friend of Wichita Police Chief **Gene Pond.** He visited in the Pond home during his stay in Wichita.

. . . WINDSOR—Plans and ideas are being formulated by the section executive committee to promote the section membership. A list of interesting and topical subjects will be discussed, along with plant tours and social events to provide an incentive for members and prospective members to attend meetings.

## *Food and Allied Industries Activities*

Division chairman Bill Golomski presented talks Jan. 19 to the Northeast Indiana section on "Operations Research for the Plant Manager and Controller." Emphasis was on foods.

Food Division members Howard Stier, C. B. Way and Mr. Golomski spoke at the Chicago Convention of National Canners' Association Jan. 24 on QC in the canning industry.

Food Division activity was evident at the Annual Conference of the Cincinnati and Hamilton-Middletown sections. Mae Goodwin Tarver, Hy Pitt and Bill Golomski presented talks.

The second issue of the Food and Allied Industries Division publication will come out in April. The first issue was sent to all division members, national officers and directors, and to 100 food companies and colleges.

# CAREER OPPORTUNITIES FOR QUALITY CONTROL ENGINEERS!

Quality Control Engineers, Statistical Analysts and Reliability Engineers have important positions at Remington Rand Univac.

As watchguards of reliability and quality control, they play a vital role in maintaining the Univac reputation of product and design integrity, and their contributions do not go unrewarded.

We realize that our superiority in ultra-reliability was achieved and can be maintained only in an *atmosphere of achievement* where individual attainment is acknowledged by individual reward.

Even though you may not be actively looking for a new position, we believe you will find complete details on these immediate openings most interesting:

**QUALITY CONTROL ENGINEERS**

To develop and apply statistical quality control techniques, initiate and evaluate test and inspection procedures for the manufacture of superior quality products.

**RELIABILITY ENGINEERS**

To perform reliability analysis and predictions, develop failure reporting procedures, analyze failures and recommend corrective action.

Openings are at several levels of responsibility. Engineering or Science degree required, with a minimum of 2 years experience in electronics or related fields.

*Salaries commensurate with experience. Company-paid relocation costs, liberal employee benefits.*

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### *Chicago Measurement Class Visits DoALL Hall of Progress*

For the second successive year the class in Precision Measurement sponsored by the Chicago ASQC section held its final meeting in DoALL Company's Hall of Progress in Des Plaines, Ill. Forty students and guests attended this session on Dec. 22.

Donald W. Mueller, chief inspector, DoALL Co., presented the technical course material on surface plates and accessories. Thomas W. Mitchell, QC manager, DoALL Co., delivered a color slide lecture on the mining of black granite and its manufacture into surface plates and other gaging equipment at the Escondido, Calif. plant of the Continental Granite Corp., DoALL affiliate.

Mr. Mueller and Mr. Mitchell collaborated as instructors for four of the 16 class sessions that comprised the 1960 course season.

**Classified Advertising**

Positions Wanted: ASQC Members 75¢, non-members $1.50 per line. Minimum space 5 lines, maximum 20 lines (2½ in. high).

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38 characters and spaces per line. Replies to box numbers and copy should be addressed to American Society for Quality Control, 161 W. Wisconsin Ave., Milwaukee 3, Wis. Deadline is 22nd of second month preceding publication.

## POSITIONS AVAILABLE

QUALITY ENGINEER FOR PULP AND PAPER OPERATIONS
Excellent opportunity for B.S. with about 4 years experience in statistical process and quality control, preferably in pulp and paper. Work includes studies of process capability, test methods, help in experimental design.

Divisional Manufacturing Standards group of leading multi-plant manufacturer. Location: Southern New England. All replies acknowledged in confidence. Please reply to Box 17W2.

"QUALITY CONTROL MANAGER: Medium size, publicly held, aggressive and growing manufacturer of Trailer-Mounted, Heating, Ventilating and Air Conditioner equipment, located in Richmond, Virginia seeks experienced Quality Control Manager, experienced in Air Force, Navy and Army Quality Control requirements. Good opportunity with excellent benefits. Please send resume and indicate recent earnings. Replies kept in confidence."

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Large building products manufacturer in South requires qualified engineer to assist in developing program including establishing controls, use of SQC techniques, inspection methods, quality audits. Will head group consisting of 2-3 statisticians and 4-6 Quality Engineers.

Prefer person 35 years or under who has Engineering or Science degree and 3-5 years industrial experience.

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Please forward complete resume' including education, experience and salary requirement to

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# clinics, conferences, and courses

**FEBRUARY**

. . . **27-Mar. 2**—18th Midwest Seminar co-sponsored by the Chicago chapter of National Office Management Association and Northwestern University at the Conrad Hilton Hotel, Chicago, Ill., contact Office Management Association of Chicago, 105 W. Madison St., Chicago 2, Ill.

**MARCH**

. . . **4—Fifth Dayton Quality Control Conference, Biltmore Hotel, Dayton, Ohio, sponsored by the Dayton section, ASQC. Contact John E. Condon, Military Development Department, National Cash Register Co., Main and K Streets, Dayton 9, Ohio.**

. . . **5-9**—Sixth Annual Gas Turbine Conference sponsored jointly by the Gas Turbine Power Division of the American Society of Mechanical Engineers and the U.S. Department of Defense at the Shoreham Hotel and the Pentagon, Washington, D.C. Contact ASME, Meetings Department, 29 West 39th St., New York 18, New York.

. . . **6-8**—Data Processing Conference, Statler Hilton Hotel, New York City, sponsored by the American Management Association. Contact AMA, 1515 Broadway, Times Square, New York 36, N. Y.

. . . **8-10**—11th Annual ISA Conference on Instrumentation for the Iron and Steel Industry, Roosevelt Hotel, Pittsburgh, Pa. Contact Richard R. Webster, Jones & Laughlin Steel Corp., Research Laboratory, 900 Agnew Ave., Pittsburgh 30, Pa.

. . . **10—Joint ASQC-AIIE Seminar "The Breakthrough to Higher Levels of Performance," Western Skies Hotel, Albuquerque, N. M. Contact Joe McDowell, 604 Amherst Dr., S. E., Albuquerque, N.M.**

. . . **11—All Day Annual QC Forum sponsored by the Toronto ASQC section, contact G. E. Culver, 78 Hearst Circle, Toronto, Ontario, Canada.**

. . . **13-14—EVOP (Evolutionary Operations) Course, Disneyland Hotel, Anaheim, Calif., sponsored by the Los Angeles section, ASQC, and the Chemical Division, ASQC. Instructors will be Paul Tidwell, Monsanto Chemical Co., and Robert Hunter. This course immediately precedes the Western Regional Conference at the same location. Course fee—$100, payable to EVOP Course, L.A. Contact A. A. Rothstein, c/o Space Technology Laboratories, Bldg. 4, Rm. 191, 5730 Arbor Vitae St., Los Angeles 45, Calif.**

. . . **14**—Plastics Finishing Seminar, sponsored by the SPE Southern California section in cooperation with the SPE Finishing Professional Activity Group, Roger Young Auditorium, Los Angeles, Calif., contact Milton T. Schimmel, Decorative Engineering and Supply, Inc., 17000 S. Western Ave., Gardena, Calif.

. . . **15—Training for Quality Control, a panel sponsored by the Washington, D.C. section of ASQC, with Dr. Harold Bright, George Washington University; John Riordan, Department of Defense, Washington, D.C., and William MacCrehan, Bendix Aviation Corp., Towson, Md. Dinner at Rich's, 6:30 p.m., 19th and E Streets, Northwest, and panel at General Services Administration Auditorium, 8 p.m., F Street, between 18th and 19th St., N.W. Contact Alfred McKeon, Bureau of Census, Washington, D.C., LU 4-3000, Ext. 285.**

. . . **15-17—Western Regional Conference, Disneyland Hotel, Anaheim, Calif. Conference immediately follows an EVOP course, Mar. 13-14, at the same location. Contact C. L. Kleppsattel, Hughes Aircraft Co., Newport Beach, Calif.**

. . . **16**—1961 Commonwealth Lecture at Lowell Technological Institute. Address by Dr. Thomas F. Malone, president of the American Meteorological Society and director of research for the Travelers Insurance Co., on "Meteorology: A Rediscovered Scientific Frontier." Cumnock Hall, 12 o'clock noon. Dr. Malone's recent research has been directed largely to the problem of weather prediction by applying statistical methods and high-speed electronic computers to an analysis of atmosphere behavior. Dr. Malone is a member of the Scientific Advisory Board of the U.S. Air Force and a member of the Advisory Panel on Science and Technology to the Committee on Science and Astronautics of the U.S. House of Representatives. Contact Director of Information, Lowell Technological Institute, Lowell, Mass.

. . . **16-17—Annual Quality Control Clinic at the University of Tennessee sponsored by the University and the ASQC Tennessee and Northeast Tennessee sections. A training program and a general program of papers will be presented simultaneously. Opening speaker—Richard Bingham, Carborundum Co., Niagara Falls, N.Y., and luncheon speaker for the second day—Irving S. Burr, Purdue University, Lafayette, Ind. Contact Director of Information, University of Tennessee, Knoxville, Tenn.**

. . . **17—Eighth Annual Industrial Clinic for Quality Control sponsored by the Milwaukee ASQC section. Topics include foods and allied industries, inspection and gaging, management, and general interest, plus a top-notch series of training sessions. Contact Riley Kelhofer, P. O. Box 1204, Milwaukee 1, Wis.**

. . . **17-18—Repeat course in evolutionary operation applied to the pulp and paper industry, Dinkler-Plaza Hotel, Atlanta, Ga., jointly sponsored by the Chemical Division, ASQC, and the Technical Association of the Pulp and Paper Industry. The first course, held Jan. 20-21 in Cleveland, Ohio, was over-subscribed. The course will again be given by Dr. J. Stuart Hunter, University of Wisconsin, and Truman L. Koehler, American Cyanamid Co., Bound Brook, N.J. Fee of $100 includes tuition, supplies, reprints, two lunches and coffee breaks. Contact TAPPI, 360 Lexington Ave., New York 17, N.Y. Hotel Reservations—TAPPI-ASQC EVOP Course, Dinkler-Plaza Hotel, Atlanta, Ga.**

. . . **20-24**—Twelfth Western Metal Congress and Exposition, Pan-Pacific Auditorium, Los Angeles, Calif., sponsored by American Society for Metals, Metals Park (Novelty), Ohio.

. . . **25—Third Annual Fifth District All Day Quality Control Conference, Scranton, Pa., see page 40, this issue.**

. . . **27-31**—3rd Symposium on Temperature—Its Measurement and Control in Science and Industry, Veterans' Memorial Hall and Deshler-Hilton Hotel, Columbus, Ohio. Sponsored by ISA, American Institute of Physics, and National Bureau of Standards. Contact ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

. . . **28—17th Annual Quality Control Clinic, University of Rochester, Rochester, N.Y., sponsored by the Rochester section, ASQC. Contact Albert D. Rickmers, associate professor, College of Graphic Arts and Photography, Rochester Institute of Technology, 65 Plymouth Avenue South, Rochester 8, N.Y.**


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Tuition fee of $225 payable to Reliability Training Conference may be sent to Mrs. Naomi McAfee, Apt. A-8, 2106 Tucker Lane, Baltimore 7, Md. Additional information may be obtained from E. V. Bersinger, Radio Corporation of America, 8500 Balboa Blvd., Van Nuys, Calif.

**CONSULTATION — 50 HOURS INSTRUCTION!**

**APRIL**

. . . **5-7**—Annual meeting of the Institute of Environmental Sciences, Sheraton Park Hotel, Washington, D.C., 70 presentations during three parallel morning and afternoon sessions, contact Institute of Environmental Sciences, Box 191, Mt. Prospect, Ill.

. . . **6-8—Sixth ASQC Workshop-Seminar, Hotel Roosevelt, New York City, Paul C. Clifford, director, professor at Montclair State College. Address inquiries to: Sixth ASQC Workshop-Seminar, ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.**

. . . **17-21**—Intensive short course in Strain Gage Techniques co-sponsored by Southwest Research Institute and the Society for Experimental Stress Analysis. Lecture program tuition—$175, supplemental laboratory tuition—$100. Submit applications and tuition by Apr. 10. Contact Dr. M. M. Lemcoe, Southwest Research Institute, Box 2296, San Antonio 6, Texas.

. . . **19—Reliability and Its Dependence on the Control of Quality by Mr. Enoch Ferrell, Bell Telephone Laboratories, Murray Hill, N.J. Dinner at Rich's, 6:30 p.m., 19th and E Streets, Northwest, and panel at General Services Administration Auditorium, 8 p.m., F Street, between 18th and 19th St., N.W. Contact Alfred McKeon, Bureau of Census, Washington, D.C., LU 4-3000, Ext. 285.**

**MAY**

. . . **9**—Plastics in the Automotive Industry sponsored by the SPE Detroit section in cooperation with the SPE Plastics in the Automotive Industry Professional Activity Group, contact John A. McPherson, Underground Products Inc., 12801 Inkster St., Livonia, Mich.

. . . **13—Quality Management Workshop under the direction of Dr. J. M. Juran, sponsored by the Portland ASQC section, contact George E. Mickel, Longview Fibre Co., P.O. Box 7035, Portland 19, Oregon.**

. . . **17—Achieving Quality, Including Reliability, at a Minimum Cost, by Dr. Harry Romig, Operations Research, Inc., Los Angeles, Calif. Dinner at Rich's, 6:30 p.m., 19th and E Streets, Northwest, and panel at General Services Administration Auditorium, 8 p.m., F Street, between 18th and 19th St., N.W. Contact Alfred McKeon, Bureau of Census, Washington, D.C., LU 4-3000, Ext. 285.**

**JUNE**

. . . **5-9**—Basic QC Course for the Graphic Arts Industry, Rochester Institute of Technology, Rochester, N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, New York.

. . . **5-16**—Intensive course in Work Design sponsored by the Department of Industrial Engineering and University College, the Adult Education Division, Washington University, St. Louis, Mo. The course will be conducted in the new Engineering Laboratory Building on the campus. Arrangements have been made for participants to be housed in the new, air-conditioned dormitories. Contact University College, Washington University, St. Louis 30, Mo.

. . . **7-17**—Design of Experiments Course, Charles R. Hicks, instructor, Purdue University, Lafayette, Ind., contact Statistical Laboratory, Engineering Administration Bldg., Purdue University, Lafayette, Indiana.

. . . **11-23**—Reliability Institute, University of Connecticut, Storrs, Conn., contact Richard M. Story, Jr., University of Connecticut, Storrs, Connecticut.

. . . **12-21**—Basic QC Course for the Chemical Industry. Rochester Institute of Technology, Rochester, N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, N.Y.

. . . **22-29**—Advanced QC Course for the Chemical Industry, Rochester Institute of Technology, Rochester, N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, New York.


## CONSULTING SERVICES

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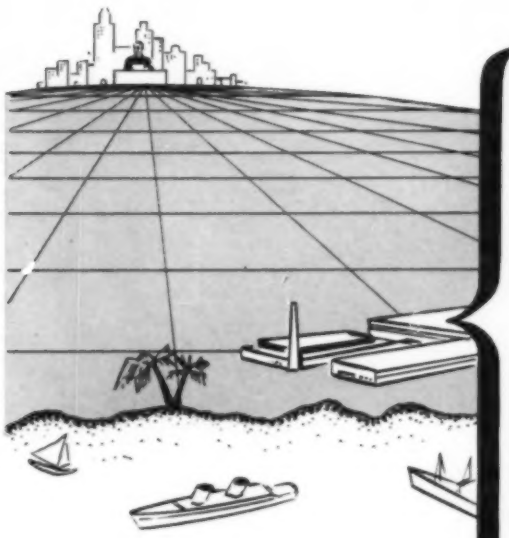

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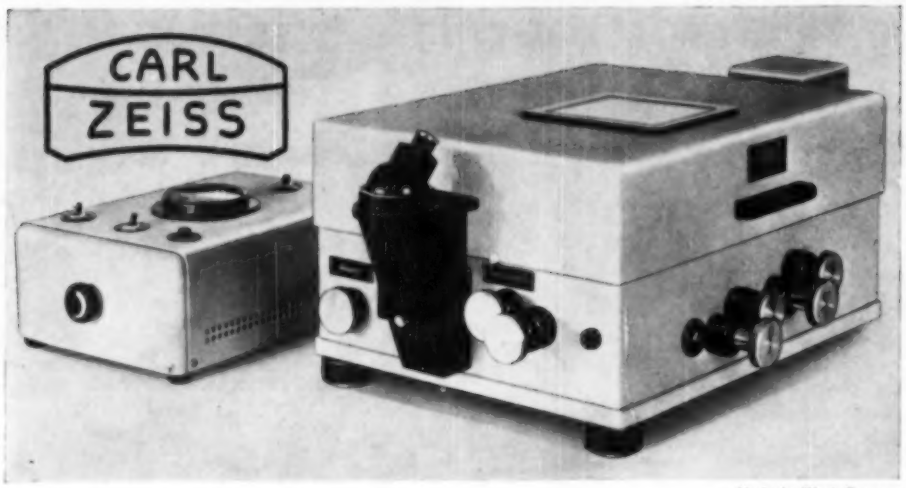


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# Carl Zeiss Gauge Block Interferometer

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This compact instrument is easy to operate and assures reliable checking of gauge blocks.

Three wave-lengths of a cadmium light source are used for the measurement. Faulty adjustments are impossible because the adjusting range of the spectrum lamp shows only the red, green and blue bands. Displacement of the interference bands need not be estimated—a special measuring device permits direct reading of the fractions from the scale.

The absolute length of a gauge block may be determined with this instrument by three methods:

1- By comparing the gauge block with that of a standard block.

2- By a combined measurement of three unknown gauge blocks (three-block measurement).

3- By measurement with wrung-on gauge block.

Measurement of two different gauge blocks is also possible (differential measurement) as well as measurement by comparison of two gauge blocks of equal length. The relative measurement may, moreover, be rechecked by white-light interferences.

All optical components of the instrument are mounted on a sturdy cast-metal base, and are protected by a hinged lid. Housing of the cadmium lamp is attached to the back of the case, opposite oblique eyepiece. Rotating knobs on front operate adjustment of the three wave-lengths and measuring device. Gauge blocks are placed on adjustable tables of instrument and fixed by holders. For measurement with the wrung-on gauge block, the path of rays is deviated by inserting two mirrors while the adjustment is maintained.

•

*Write for booklet which gives complete details.*

•

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